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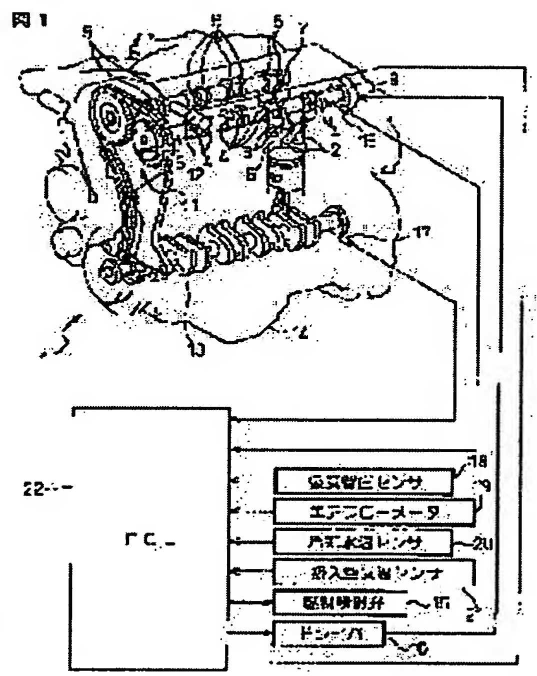
(54) CONTROLLER OF INTERNAL COMBUSTION ENGINE

(57)Abstract:



PROBLEM TO BE SOLVED: To properly control an internal combustion engine even when an opening area or an operating angle of intake and exhaust valves are changed by controlling the internal combustion engine on the basis of not only the cylinder internal pressure at the peak of combustion pressure but also the cylinder internal pressure at a time excluding the peak of the combustion pressure.

SOLUTION: This controller comprises a valve lifting amount changing device 9 as a variable valve system for changing an opening area or an operating angle of at least one of the intake valve 2 and the exhaust valve 3, the cylinder internal pressure is calculated on the basis of the opening area or the operating angle of at least one of the intake valve 2 and the exhaust valve 3, and the internal combustion engine is controlled on the basis of the cylinder internal pressure.

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* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] The control unit of the internal combustion engine characterized by providing the good fluctuation valve system for changing one [at least] opening area of an inlet valve and an exhaust valve in the control unit of the internal combustion engine which controlled the internal combustion engine based on cylinder internal pressure, computing cylinder internal pressure based on one [at least] opening area of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, and controlling an internal combustion engine based on the cylinder internal pressure.
[Claim 2] The control unit of the internal combustion engine characterized by providing the good fluctuation valve system for changing one [at least] working angle of an inlet valve and an exhaust valve in the control unit of the internal combustion engine which controlled the internal combustion engine based on cylinder internal pressure, computing cylinder internal pressure based on one [at least] working angle of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, and controlling an internal combustion engine based on the cylinder internal pressure.
[Claim 3] The control unit of the internal combustion engine according to claim 1 or 2 characterized by providing the good fluctuation valve system for changing one [at least] opening area and working angle of an inlet valve and an exhaust valve, computing cylinder internal pressure based on one [at least] opening area and working angle of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, and controlling an internal combustion engine based on the cylinder internal pressure.
[Claim 4] The control unit of the internal combustion engine according to claim 3 characterized by computing cylinder internal pressure based on the phase of an inlet valve, the pressure within inhalation of air, and an engine rotational frequency, and controlling an internal combustion engine based on the cylinder internal pressure.
[Claim 5] In the control unit of the internal combustion engine which controlled the internal combustion engine based on the temperature of a certain part in a gas column The good fluctuation valve system for changing one [at least] opening area of an inlet valve and an exhaust valve is provided. The control unit of the internal combustion engine characterized by computing the gas temperature in a cylinder based on one [at least] opening area of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, and controlling an internal combustion engine based on the gas temperature in the cylinder.
[Claim 6] The control unit of the internal combustion engine characterized by to provide the good fluctuation valve system for changing one [at least] working angle of an inlet valve and an exhaust valve in the control unit of the internal combustion engine which controlled the internal combustion engine based on the temperature of a certain part in a gas column, to compute the gas temperature in a cylinder based on one [at least] working angle of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, and to control an internal combustion engine based on the gas temperature in the cylinder.
[Claim 7] The control unit of the internal combustion engine according to claim 5 or 6 characterized by providing the good fluctuation valve system for changing one [at least] opening area and working angle of an inlet valve and an exhaust valve, computing the gas temperature in a cylinder

based on one [at least] opening area and working angle of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, and controlling an internal combustion engine based on the gas temperature in the cylinder.
[Claim 8] The control unit of the internal combustion engine according to claim 7 characterized by computing the gas temperature in a cylinder based on the phase of an inlet valve, the pressure within inhalation of air, and an engine rotational frequency, and controlling an internal combustion engine based on the gas temperature in the cylinder.
[Claim 9] The control unit of an internal combustion engine given in any 1 term of claims 5-8 characterized by amending the gas temperature in a cylinder based on at least one of a cylinder wall temperature, an engine rotational frequency, an inhalation air content, the amount of internal EGR gas, and internal EGR gas temperature.
[Claim 10] In the control unit of the internal combustion engine which possesses the good fluctuation valve system for either [at least] an inlet valve or an exhaust valve, and controlled the internal combustion engine based on the internal EGR gas rate or the amount The control unit of the internal combustion engine characterized by computing an internal EGR gas rate or an amount based on one [at least] opening area of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, and controlling an internal combustion engine based on the internal EGR gas rate or amount.
[Claim 11] The control unit of the internal combustion engine characterized by to provide the good fluctuation valve system for either [at least] an inlet valve or an exhaust valve, to compute an internal EGR gas rate or an amount based on one [at least] working angle of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system in the control unit of the internal combustion engine which controlled the internal combustion engine based on the internal EGR gas rate or the amount, and to control an internal combustion engine based on the internal EGR gas rate or amount.
[Claim 12] The control unit of the internal combustion engine according to claim 10 or 11 characterized by computing an internal EGR gas rate or an amount based on one [at least] opening area and working angle of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, and controlling an internal combustion engine based on the internal EGR gas rate or amount.
[Claim 13] The control unit of the internal combustion engine according to claim 12 characterized by computing an internal EGR gas rate or an amount based on the phase of an inlet valve, the pressure within inhalation of air, and an engine rotational frequency, and controlling an internal combustion engine based on the internal EGR gas rate or amount.
[Claim 14] The control unit of an internal combustion engine given in any 1 term of claims 10-13 characterized by amending an internal EGR gas rate or an amount based on at least one of atmospheric pressure, the pressure in an exhaust pipe and the internal EGR gas rate computed last time, or amounts.
[Claim 15] The control unit of the internal combustion engine according to claim 10 characterized by computing an internal EGR gas rate or an amount based on one [at least] opening area of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, and the pressure of the upstream of the inlet valve in a bulb overlap period and the pressure of the downstream, and controlling an internal combustion engine based on the internal EGR gas rate or amount.
[Claim 16] The opening area for one [at least] predetermined time of every of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, Based on the pressure of the upstream of the inlet valve for every predetermined time in a bulb overlap period, and the pressure of the downstream, the interior EGR gas rate of an instant or an amount is computed. The control unit of the internal combustion engine according to claim 15 characterized by controlling an internal combustion engine based on the internal EGR gas rate or amount obtained by integrating the interior EGR gas rate of an instant or amount.
[Claim 17] The good fluctuation valve system for either [at least] an inlet valve or an exhaust valve is provided. In the control unit of the internal combustion engine which presumes extent of the turbulence in a cylinder based on the opening area of the inlet valve you are made to change by the good fluctuation valve system, and controlled the internal combustion engine based on extent of the

turbulence in the cylinder The control unit of the internal combustion engine characterized by presuming that extent of the turbulence in a cylinder increases as the opening area of the inlet valve you are made to change by the good fluctuation valve system decreases, and controlling an internal combustion engine based on extent of the turbulence in the presumed cylinder.

[Claim 18] The control unit of the internal combustion engine according to claim 17 characterized by presuming extent of the turbulence in a cylinder based on the working angle of an inlet valve, the phase of an inlet valve, the pressure within inhalation of air, and an engine rotational frequency, and controlling an internal combustion engine based on extent of the turbulence in the presumed cylinder.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to an internal combustion engine's control unit.
[0002]
[Description of the Prior Art] Conventionally, the control unit of the internal combustion engine which controlled the internal combustion engine based on cylinder internal pressure is known. As an example of this kind of internal combustion engine's control unit, there are some which were indicated by JP,9-53503,A, for example. Fuel oil consumption and ignition timing are computed based on the output value of the cylinder internal pressure sensor for detecting cylinder internal pressure, and the internal combustion engine is controlled by an internal combustion engine's control unit indicated by JP,9-53503,A based on the computed fuel oil consumption and ignition timing.
[0003]
[Problem(s) to be Solved by the Invention] However, when cylinder internal pressure is detected by the cylinder internal pressure sensor like an internal combustion engine's control unit indicated by JP,9-53503,A, the detected cylinder internal pressure is a thing at the time of combustion pressure serving as a peak, and becomes a thing at the time of whenever [after / a compression top dead center / 10 - 15 crank-angle]. Therefore, depending on an internal combustion engine's control unit indicated by JP,9-53503,A, an internal combustion engine is uncontrollable based on cylinder internal pressure at the times other than a combustion pressure peak period like the cylinder internal pressure at the time of a compression top dead center, for example. When the opening area or the working angle of an induction-exhaust valve is made to change depending on an internal combustion engine's control unit indicated by JP,9-53503,A which is not taking into consideration that cylinder internal pressure changes in connection with the opening area or the working angle of an induction-exhaust valve being made to change by the moreover, for example, good fluctuation, valve system, an internal combustion engine cannot be controlled appropriately.
[0004] Moreover, the control unit of the internal combustion engine which controlled the internal combustion engine based on the temperature of a certain part in a gas column is known conventionally. As an example of this kind of internal combustion engine's control unit, there are some which were indicated by JP,4-81574,A, for example. Ignition timing is computed based on the output value of the wall-temperature sensor for detecting cylinder wall **, and the internal combustion engine is controlled by an internal combustion engine's control unit indicated by JP,4-81574,A based on the computed ignition timing.
[0005] By the way, although ignition timing is computed based on cylinder wall ** and the internal combustion engine is controlled by an internal combustion engine's control unit indicated to have mentioned above by JP,4-81574,A based on the ignition timing, with cylinder wall ** and the gas temperature in a cylinder, there is a remarkable difference and it can be said that suitable ignition timing becomes settled rather than a cylinder wall temperature based on the gas temperature in a cylinder. Therefore, depending on an internal combustion engine's control unit indicated by JP,4-81574,A by which ignition timing is computed based on cylinder wall **, an internal combustion engine is appropriately uncontrollable. When the opening area or the working angle of an induction-exhaust valve is made to change depending on an internal combustion engine's control unit indicated by JP,4-81574,A which is not taking into consideration that the gas temperature in a cylinder

changes in connection with the opening area or the working angle of an induction-exhaust valve being made to change by the moreover, for example, good fluctuation, valve system, an internal combustion engine cannot be controlled appropriately.

[0006] Moreover, conventionally, the good fluctuation valve system for either [at least] an inlet valve or an exhaust valve is provided, and the control unit of the internal combustion engine which controlled the internal combustion engine based on the internal EGR gas rate or the amount is known. As an example of this kind of internal combustion engine's control unit, there are some which were indicated by JP,9-209895,A, for example. In an internal combustion engine's control unit indicated by JP,9-209895,A The good fluctuation valve system to which closing motion timing (valve timing) is shifted, without changing the die length of the valve-opening period of an inlet valve is prepared. Based on the sum with the amount of the burnt gas which remains as it is, ignition timing is computed in a gas column, without being discharged from the amount and gas column of a burnt gas which are again inhaled in a gas column, after being blown by the amount of internal EGR gas (the amount of internal exhaust gas recycling), i.e., an inhalation of air within the pipe one. The internal combustion engine is controlled based on the computed ignition timing.

[0007] However, in an internal combustion engine's control unit indicated by JP,9-209895,A, although the shift amount of the closing motion timing of an induction-exhaust valve is taken into consideration when computing the amount of internal EGR gas, the amount of modification of the opening area of an induction-exhaust valve is not taken into consideration. On the other hand, the function to change the amount of valve lifts into a good fluctuation valve system is prepared, and when the opening area of an induction-exhaust valve is made to change by changing the amount of valve lifts, even if the closing motion timing of an induction-exhaust valve is not shifted, the actual amount of internal EGR gas is changed considerably. Therefore, if the amount of internal EGR gas is computed without taking into consideration modification of the opening area of an induction-exhaust valve with an internal combustion engine's control unit indicated by JP,9-209895,A when the opening area of an induction-exhaust valve is made to change, the computed amount of internal EGR gas and the actual amount of internal EGR gas will be considerably different. When the opening area of an induction-exhaust valve is made to change depending on an internal combustion engine's control unit indicated by JP,9-209895,A which is not taking into consideration that the amount of internal EGR gas changes in connection with getting it blocked, for example, the opening area of an induction-exhaust valve being made to change by the good fluctuation valve system, the amount of internal EGR gas cannot be computed correctly, and an internal combustion engine cannot be controlled appropriately.

[0008] Moreover, in an internal combustion engine's control unit indicated by JP,9-209895,A, although the shift amount of the closing motion timing of an induction-exhaust valve is taken into consideration when computing the amount of internal EGR gas, the amount of modification of the working angle of an induction-exhaust valve of modification, i.e., the amount of the angle of rotation of the cam shaft equivalent to the valve-opening period of an induction-exhaust valve, is not taken into consideration. On the other hand, when the function, i.e., the function to make the valve-opening period of an induction-exhaust valve fluctuate, to change the working angle of an induction-exhaust valve into a good fluctuation valve system is prepared and the working angle of an induction-exhaust valve is made to change, whether the closing motion timing of an induction-exhaust valve is not shifted or the peak timing of the amount of valve lifts is not changed that is, the actual amount of internal EGR gas is changed considerably. Therefore, if the amount of internal EGR gas is computed without taking into consideration modification of the working angle of an induction-exhaust valve with an internal combustion engine's control unit indicated by JP,9-209895,A when the working angle of an induction-exhaust valve is made to change, the computed amount of internal EGR gas and the actual amount of internal EGR gas will be considerably different. When the working angle of an induction-exhaust valve is made to change depending on an internal combustion engine's control unit indicated by JP,9-209895,A which is not taking into consideration that the amount of internal EGR gas changes in connection with getting it blocked, for example, the working angle of an induction-exhaust valve being made to change by the good fluctuation valve system, the amount of internal EGR gas cannot be computed correctly, and an internal combustion engine cannot be controlled appropriately.

[0009] Moreover, conventionally, the good fluctuation valve system for either [at least] an inlet valve or an exhaust valve is provided, extent of the turbulence in a cylinder is presumed based on the opening area of the inlet valve you are made to change by the good fluctuation valve system, and the control unit of the internal combustion engine which controlled the internal combustion engine based on extent of the turbulence in the cylinder is known. As an example of this kind of internal combustion engine's control unit, there are some which were indicated by JP,2000-73800,A, for example. In an internal combustion engine's control unit indicated by JP,2000-73800,A, it is presumed that extent of the turbulence in a cylinder decreases as the opening area of the inlet valve you are made to change by the good fluctuation valve system decreases.
[0010] However, in an internal combustion engine's control unit indicated by JP,2000-73800,A, although it is presumed that extent of the turbulence in a cylinder decreases as the opening area of the inlet valve you are made to change by the good fluctuation valve system decreases, extent of the turbulence in a cylinder increases as the opening area of the inlet valve you are made to change by the good fluctuation valve system decreases actually. Therefore, if it presumes that extent of the turbulence in a cylinder decreases and an internal combustion engine is controlled based on extent of the turbulence in the presumed cylinder as the opening area of an inlet valve decreases like [in the case of an internal combustion engine's control unit indicated by JP,2000-73800,A], when the opening area of an inlet valve is made to change by the good fluctuation valve system, an internal combustion engine will no longer be controlled appropriately.
[0011] In view of said trouble, this invention can control an internal combustion engine not only based on the cylinder internal pressure of a combustion pressure peak period but based on the cylinder internal pressure at the times other than a combustion pressure peak period, and even if it is the case where the opening area or the working angle of an induction-exhaust valve is made to change, it aims at offering the control unit of the internal combustion engine which can control an internal combustion engine appropriately.
[0012] Furthermore, even if this invention is the case where control an internal combustion engine appropriately and the opening area or the working angle of an induction-exhaust valve is made to change him rather than the case where an internal combustion engine is controlled based on cylinder wall **, it aims at offering the control unit of the internal combustion engine which can control an internal combustion engine appropriately.
[0013] Furthermore, even if this invention is the case where the opening area or the working angle of an induction-exhaust valve is made to change, it computes the amount of internal EGR gas correctly, and it aims at offering the control unit of the internal combustion engine which can control an internal combustion engine appropriately.
[0014] Furthermore, even if this invention is the case where the opening area of an inlet valve is made to change by the good fluctuation valve system, it aims at offering the control unit of the internal combustion engine which can presume extent of the turbulence in a cylinder correctly and can control an internal combustion engine appropriately.
[0015]
[Means for Solving the Problem] In the control unit of the internal combustion engine which controlled the internal combustion engine based on cylinder internal pressure according to invention according to claim 1 The good fluctuation valve system for changing one [at least] opening area of an inlet valve and an exhaust valve is provided. Cylinder internal pressure is computed based on one [at least] opening area of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, and the control unit of the internal combustion engine characterized by controlling an internal combustion engine based on the cylinder internal pressure is offered.
[0016] In the control unit of an internal combustion engine according to claim 1, cylinder internal pressure is computed based on one [at least] opening area of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system. Therefore, unlike the case where cylinder internal pressure is detected, not only based on the cylinder internal pressure of a combustion pressure peak period but the cylinder internal pressure at the times other than a combustion pressure peak period, an internal combustion engine is controllable by the cylinder internal pressure sensor like an internal combustion engine's control unit indicated by JP,9-53503,A. Furthermore, since an internal combustion engine is controlled according to the cylinder internal pressure computed based

on one [at least] opening area of an inlet valve and an exhaust valve, even if it is the case where the opening area of an induction-exhaust valve is made to change, an internal combustion engine is appropriately controllable. An internal combustion engine is controlled so that ignition timing carries out a lag, as the cylinder internal pressure computed based on the opening area of an inlet valve as the opening area of an inlet valve increases to a detail increases and cylinder internal pressure increases. Or an internal combustion engine is controlled so that fuel oil consumption is made to increase, as the cylinder internal pressure computed based on the opening area of an inlet valve as the opening area of an inlet valve increases increases and cylinder internal pressure increases.
[0017] In the control unit of the internal combustion engine which controlled the internal combustion engine based on cylinder internal pressure according to invention according to claim 2 The good fluctuation valve system for changing one [at least] working angle of an inlet valve and an exhaust valve is provided. Cylinder internal pressure is computed based on one [at least] working angle of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, and the control unit of the internal combustion engine characterized by controlling an internal combustion engine based on the cylinder internal pressure is offered.
[0018] In the control unit of an internal combustion engine according to claim 2, cylinder internal pressure is computed based on one [at least] working angle of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system. Therefore, unlike the case where cylinder internal pressure is detected, not only based on the cylinder internal pressure of a combustion pressure peak period but the cylinder internal pressure at the times other than a combustion pressure peak period, an internal combustion engine is controllable by the cylinder internal pressure sensor like an internal combustion engine's control unit indicated by JP,9-53503,A. Furthermore, since an internal combustion engine is controlled according to the cylinder internal pressure computed based on one [at least] working angle of an inlet valve and an exhaust valve, even if it is the case where the working angle of an induction-exhaust valve is made to change, an internal combustion engine is appropriately controllable. An internal combustion engine is controlled so that ignition timing carries out a lag, as the cylinder internal pressure computed based on the working angle of an inlet valve as the working angle of an inlet valve decreases, when an inlet valve carries out a close by-pass bulb completely to a detail for example, after an inhalation-of-air bottom dead point increases and cylinder internal pressure increases. Moreover, an internal combustion engine is controlled so that ignition timing carries out a lag, as the cylinder internal pressure computed based on the working angle of an inlet valve as the working angle of an inlet valve increases, when an inlet valve carries out a close by-pass bulb completely before an inhalation-of-air bottom dead point increases and cylinder internal pressure increases. Or an internal combustion engine is controlled so that fuel oil consumption is made to increase, as the cylinder internal pressure computed based on the working angle of an inlet valve as the working angle of an inlet valve decreases increases and cylinder internal pressure increases.
[0019] According to invention according to claim 3, the good fluctuation valve system for changing one [at least] opening area and working angle of an inlet valve and an exhaust valve is provided. Cylinder internal pressure is computed based on one [at least] opening area and working angle of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, and the control unit of the internal combustion engine according to claim 1 or 2 characterized by controlling an internal combustion engine based on the cylinder internal pressure is offered.
[0020] Cylinder internal pressure is computed based on one [at least] opening area and working angle of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, and an internal combustion engine is controlled by the control unit of an internal combustion engine according to claim 3 based on the cylinder internal pressure. Therefore, rather than the case where cylinder internal pressure is computed only based on the opening area of an induction-exhaust valve, without being based on the working angle of an induction-exhaust valve, and the case where cylinder internal pressure is computed based on the operation corner chisel of an induction-exhaust valve, without being based on the opening area of an induction-exhaust valve, cylinder internal pressure can be computed correctly and an internal combustion engine can be controlled appropriately.
[0021] According to invention according to claim 4, cylinder internal pressure is computed based on

the phase of an inlet valve, the pressure within inhalation of air, and an engine rotational frequency, and the control unit of the internal combustion engine according to claim 3 characterized by controlling an internal combustion engine based on the cylinder internal pressure is offered.
[0022] Cylinder internal pressure is computed based on the phase of an inlet valve, the pressure within inhalation of air, and an engine rotational frequency, and an internal combustion engine is controlled by the control unit of an internal combustion engine according to claim 4 based on the cylinder internal pressure. Therefore, rather than the case where cylinder internal pressure is not computed based on the phase of an inlet valve, the pressure within inhalation of air, and an engine rotational frequency, cylinder internal pressure can be computed correctly and an internal combustion engine can be controlled appropriately.
[0023] In the control unit of the internal combustion engine which controlled the internal combustion engine based on the temperature of a certain part in a gas column according to invention according to claim 5 The good fluctuation valve system for changing one [at least] opening area of an inlet valve and an exhaust valve is provided. The gas temperature in a cylinder is computed based on one [at least] opening area of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, and the control unit of the internal combustion engine characterized by controlling an internal combustion engine based on the gas temperature in the cylinder is offered.
[0024] The gas temperature in a cylinder is computed based on one [at least] opening area of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, and an internal combustion engine is controlled by the control unit of an internal combustion engine according to claim 5 based on the gas temperature in the cylinder. Therefore, an internal combustion engine is appropriately controllable from the case where an internal combustion engine is controlled based on cylinder wall ** like an internal combustion engine's control unit indicated by JP,4-81574,A. Furthermore, since an internal combustion engine is controlled according to the gas temperature in a cylinder computed based on one [at least] opening area of an inlet valve and an exhaust valve, even if it is the case where the opening area of an induction-exhaust valve is made to change, an internal combustion engine is appropriately controllable. An internal combustion engine is controlled so that ignition timing carries out a lag, as the gas temperature in a cylinder computed based on the opening area of an inlet valve as the opening area of an inlet valve increases to a detail becomes high and the gas temperature in a cylinder becomes high.
[0025] In the control unit of the internal combustion engine which controlled the internal combustion engine based on the temperature of a certain part in a gas column according to invention according to claim 6 The good fluctuation valve system for changing one [at least] working angle of an inlet valve and an exhaust valve is provided. The gas temperature in a cylinder is computed based on one [at least] working angle of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, and the control unit of the internal combustion engine characterized by controlling an internal combustion engine based on the gas temperature in the cylinder is offered.
[0026] The gas temperature in a cylinder is computed based on one [at least] working angle of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, and an internal combustion engine is controlled by the control unit of an internal combustion engine according to claim 6 based on the gas temperature in the cylinder. Therefore, an internal combustion engine is appropriately controllable from the case where an internal combustion engine is controlled based on cylinder wall ** like an internal combustion engine's control unit indicated by JP,4-81574,A. Furthermore, since an internal combustion engine is controlled according to the gas temperature in a cylinder computed based on one [at least] working angle of an inlet valve and an exhaust valve, even if it is the case where the working angle of an induction-exhaust valve is made to change, an internal combustion engine is appropriately controllable. An internal combustion engine is controlled so that ignition timing carries out a lag, as the gas temperature in a cylinder computed based on the working angle of an inlet valve as the working angle of an inlet valve increases, when an inlet valve carries out a close by-pass bulb completely to a detail for example, after an inhalation-of-air bottom dead point becomes high and the gas temperature in a cylinder becomes high. Moreover, an internal combustion engine is controlled so that ignition timing carries out a lag, as the gas temperature in a cylinder computed based on the working angle of an inlet valve as the working angle of an inlet valve decreases, when an inlet valve carries out a close by-pass bulb completely

before an inhalation-of-air bottom dead point becomes high and the gas temperature in a cylinder becomes high.
[0027] According to invention according to claim 7, the good fluctuation valve system for changing one [at least] opening area and working angle of an inlet valve and an exhaust valve is provided. The gas temperature in a cylinder is computed based on one [at least] opening area and working angle of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, and the control unit of the internal combustion engine according to claim 5 or 6 characterized by controlling an internal combustion engine based on the gas temperature in the cylinder is offered.
[0028] The gas temperature in a cylinder is computed based on one [at least] opening area and working angle of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, and an internal combustion engine is controlled by the control unit of an internal combustion engine according to claim 7 based on the gas temperature in the cylinder. Therefore, rather than the case where the gas temperature in a cylinder is computed only based on the opening area of an induction-exhaust valve, without being based on the working angle of an induction-exhaust valve, and the case where the gas temperature in a cylinder is computed based on the operation corner chisel of an induction-exhaust valve, without being based on the opening area of an induction-exhaust valve, the gas temperature in a cylinder can be computed correctly and an internal combustion engine can be controlled appropriately.
[0029] According to invention according to claim 8, the gas temperature in a cylinder is computed based on the phase of an inlet valve, the pressure within inhalation of air, and an engine rotational frequency, and the control unit of the internal combustion engine according to claim 7 characterized by controlling an internal combustion engine based on the gas temperature in the cylinder is offered.
[0030] The gas temperature in a cylinder is computed based on the phase of an inlet valve, the pressure within inhalation of air, and an engine rotational frequency, and an internal combustion engine is controlled by the control unit of an internal combustion engine according to claim 8 based on the gas temperature in the cylinder. Therefore, rather than the case where the gas temperature in a cylinder is not computed based on the phase of an inlet valve, the pressure within inhalation of air, and an engine rotational frequency, the gas temperature in a cylinder can be computed correctly and an internal combustion engine can be controlled appropriately.
[0031] According to invention according to claim 9, any 1 term of claims 5-8 characterized by amending the gas temperature in a cylinder based on at least one of a cylinder wall temperature, an engine rotational frequency, an inhalation air content, the amount of internal EGR gas, and internal EGR gas temperature is provided with the control unit of the internal combustion engine of a publication.
[0032] Since the gas temperature in a cylinder is amended based on at least one of a cylinder wall temperature, an engine rotational frequency, an inhalation air content, the amount of internal EGR gas, and internal EGR gas temperature, an internal combustion engine is appropriately controllable by the control unit of an internal combustion engine according to claim 9 from the case where the gas temperature in a cylinder is not amended based on at least one of them.
[0033] In the control unit of the internal combustion engine which according to invention according to claim 10 possesses the good fluctuation valve system for either [at least] an inlet valve or an exhaust valve, and controlled the internal combustion engine based on the internal EGR gas rate or the amount Based on one [at least] opening area of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, an internal EGR gas rate or an amount is computed, and the control unit of the internal combustion engine characterized by controlling an internal combustion engine based on the internal EGR gas rate or amount is offered.
[0034] Based on one [at least] opening area of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, an internal EGR gas rate or an amount is computed, and an internal combustion engine is controlled by the control unit of an internal combustion engine according to claim 10 based on the internal EGR gas rate or amount. Therefore, without taking into consideration modification of the opening area of the induction-exhaust valve by the good fluctuation valve system like an internal combustion engine's control unit indicated by JP,9-209895,A, rather than the case where an internal EGR gas rate or an amount is computed, an internal

EGR gas rate or an amount can be computed correctly, and an internal combustion engine can be controlled appropriately. That is, even if it is the case where the opening area of an induction-exhaust valve is made to change, the amount of internal EGR gas can be computed correctly, and an internal combustion engine can be controlled appropriately. An internal combustion engine is controlled so that ignition timing carries out a tooth lead angle, as the internal EGR gas rate or amount computed based on the opening area of an inlet valve as the opening area of an inlet valve increases to a detail increases and an internal EGR gas rate or an amount increases.
[0035] In the control unit of the internal combustion engine which according to invention according to claim 11 possesses the good fluctuation valve system for either [at least] an inlet valve or an exhaust valve, and controlled the internal combustion engine based on the internal EGR gas rate or the amount Based on one [at least] working angle of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, an internal EGR gas rate or an amount is computed, and the control unit of the internal combustion engine characterized by controlling an internal combustion engine based on the internal EGR gas rate or amount is offered.
[0036] Based on one [at least] working angle of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, an internal EGR gas rate or an amount is computed, and an internal combustion engine is controlled by the control unit of an internal combustion engine according to claim 11 based on the internal EGR gas rate or amount. Therefore, without taking into consideration modification of the working angle of the induction-exhaust valve by the good fluctuation valve system like an internal combustion engine's control unit indicated by JP,9-209895,A, rather than the case where an internal EGR gas rate or an amount is computed, an internal EGR gas rate or an amount can be computed correctly, and an internal combustion engine can be controlled appropriately. That is, even if it is the case where the working angle of an induction-exhaust valve is made to change, the amount of internal EGR gas can be computed correctly, and an internal combustion engine can be controlled appropriately. An internal combustion engine is controlled so that ignition timing carries out a tooth lead angle, as the internal EGR gas rate or amount computed based on the working angle of an inlet valve as the working angle of an inlet valve increases to a detail increases and an internal EGR gas rate or an amount increases.
[0037] According to invention according to claim 12, based on one [at least] opening area and working angle of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, an internal EGR gas rate or an amount is computed, and the control unit of the internal combustion engine according to claim 10 or 11 characterized by controlling an internal combustion engine based on the internal EGR gas rate or amount is offered.
[0038] Based on one [at least] opening area and working angle of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, an internal EGR gas rate or an amount is computed, and an internal combustion engine is controlled by the control unit of an internal combustion engine according to claim 12 based on the internal EGR gas rate or amount. Therefore, rather than the case where an internal EGR gas rate or an amount is computed only based on the opening area of an induction-exhaust valve, without being based on the working angle of an induction-exhaust valve, and the case where an internal EGR gas rate or an amount is computed based on the operation corner chisel of an induction-exhaust valve, without being based on the opening area of an induction-exhaust valve, an internal EGR gas rate or an amount can be computed correctly, and an internal combustion engine can be controlled appropriately.
[0039] According to invention according to claim 13, based on the phase of an inlet valve, the pressure within inhalation of air, and an engine rotational frequency, an internal EGR gas rate or an amount is computed, and the control unit of the internal combustion engine according to claim 12 characterized by controlling an internal combustion engine based on the internal EGR gas rate or amount is offered.
[0040] Based on the phase of an inlet valve, the pressure within inhalation of air, and an engine rotational frequency, an internal EGR gas rate or an amount is computed, and an internal combustion engine is controlled by the control unit of an internal combustion engine according to claim 13 based on the internal EGR gas rate or amount. Therefore, rather than the case where an internal EGR gas rate or an amount is not computed based on the phase of an inlet valve, the pressure within inhalation of air, and an engine rotational frequency, an internal EGR gas rate or an amount can be computed

correctly, and an internal combustion engine can be controlled appropriately.
[0041] According to invention according to claim 14, any 1 term of claims 10-13 characterized by amending an internal EGR gas rate or an amount based on at least one of atmospheric pressure, the pressure in an exhaust pipe and the internal EGR gas rate computed last time, or amounts is provided with the control unit of the internal combustion engine of a publication.
[0042] Since an internal EGR gas rate or an amount is amended based on at least one of atmospheric pressure, the pressure in an exhaust pipe and the internal EGR gas rate computed last time, or amounts, an internal combustion engine is appropriately controllable by the control unit of an internal combustion engine according to claim 14 from the case where an internal EGR gas rate or an amount is not amended based on at least one of them.
[0043] According to invention according to claim 15, based on one [at least] opening area of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, and the pressure of the upstream of the inlet valve in a bulb overlap period and the pressure of the downstream, an internal EGR gas rate or an amount is computed, and the control unit of the internal combustion engine according to claim 10 characterized by controlling an internal combustion engine based on the internal EGR gas rate or amount is offered.
[0044] Based on one [at least] opening area of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, and the pressure of the upstream of the inlet valve in a bulb overlap period and the pressure of the downstream, an internal EGR gas rate or an amount is computed, and an internal combustion engine is controlled by the control unit of an internal combustion engine according to claim 15 based on the internal EGR gas rate or amount. Therefore, rather than the case where an internal EGR gas rate or an amount is computed only based on one [at least] opening area of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, and an internal EGR gas rate or an amount is not computed based on the pressure of the upstream of the inlet valve in a bulb overlap period, and the pressure of the downstream, an internal EGR gas rate or an amount can be computed correctly, and an internal combustion engine can be controlled appropriately.
[0045] The opening area for one [at least] predetermined time of every of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system according to invention according to claim 16, Based on the pressure of the upstream of the inlet valve for every predetermined time in a bulb overlap period, and the pressure of the downstream, the interior EGR gas rate of an instant or an amount is computed. The control unit of the internal combustion engine according to claim 15 characterized by controlling an internal combustion engine based on the internal EGR gas rate or amount obtained by integrating the interior EGR gas rate of an instant or amount is offered.
[0046] In the control unit of an internal combustion engine according to claim 16 The opening area for one [at least] predetermined time of every of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, Based on the pressure of the upstream of the inlet valve for every predetermined time in a bulb overlap period, and the pressure of the downstream, the interior EGR gas rate of an instant or an amount is computed. An internal combustion engine is controlled based on the internal EGR gas rate or amount obtained by integrating the interior EGR gas rate of an instant or amount. Therefore, even if it is the case that change of the opening area of an induction-exhaust valve, the pressure of the upstream of the inlet valve in a bulb overlap period, and the pressure of the downstream is large, an internal EGR gas rate or an amount can be computed correctly, and an internal combustion engine can be controlled appropriately.
[0047] According to invention according to claim 17, the good fluctuation valve system for either [at least] an inlet valve or an exhaust valve is provided. In the control unit of the internal combustion engine which presumes extent of the turbulence in a cylinder based on the opening area of the inlet valve you are made to change by the good fluctuation valve system, and controlled the internal combustion engine based on extent of the turbulence in the cylinder It presumes that extent of the turbulence in a cylinder increases as the opening area of the inlet valve you are made to change by the good fluctuation valve system decreases, and the control unit of the internal combustion engine characterized by controlling an internal combustion engine based on extent of the turbulence in the presumed cylinder is offered.

[0048] It is presumed that extent of the turbulence in a cylinder increases as the opening area of the inlet valve you are made to change by the good fluctuation valve system decreases, and based on extent of the turbulence in the presumed cylinder, an internal combustion engine is controlled by the control unit of an internal combustion engine according to claim 17. Therefore, it is presumed that extent of the turbulence in a cylinder decreases as the opening area of an inlet valve decreases. It differs from an internal combustion engine's control unit indicated by JP,2000-73800,A by which an internal combustion engine is controlled based on extent of the turbulence in the presumed cylinder. Even if it is the case where the opening area of an inlet valve is made to change by the good fluctuation valve system, extent of the turbulence in a cylinder can be presumed correctly and an internal combustion engine can be controlled appropriately. An internal combustion engine is controlled so that ignition timing carries out a lag, as extent of the turbulence in a cylinder presumed based on the opening area of an inlet valve as the opening area of an inlet valve decreases in a detail increases and extent of the turbulence in a cylinder increases.
[0049] According to invention according to claim 18, extent of the turbulence in a cylinder is presumed based on the working angle of an inlet valve, the phase of an inlet valve, the pressure within inhalation of air, and an engine rotational frequency, and the control unit of the internal combustion engine according to claim 17 characterized by controlling an internal combustion engine based on extent of the turbulence in the presumed cylinder is offered.
[0050] Extent of the turbulence in a cylinder is presumed based on the phase of an inlet valve, the pressure within inhalation of air, and an engine rotational frequency, and an internal combustion engine is controlled by the control unit of an internal combustion engine according to claim 18 based on extent of the turbulence in the presumed cylinder. Therefore, rather than the case where extent of the turbulence in a cylinder is not presumed based on the phase of an inlet valve, the pressure within inhalation of air, and an engine rotational frequency, extent of the turbulence in a cylinder can be presumed correctly and an internal combustion engine can be controlled appropriately.
[0051]
[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained using an accompanying drawing.
[0052] They are detail drawing, such as an inhalation-of-air system of the control unit of the internal combustion engine which showed drawing 1 in the outline block diagram of the first operation gestalt of the control unit of the internal combustion engine of this invention, and showed drawing 2 to drawing 1 . In drawing 1 and drawing 2 , a cam for a cam for an inlet valve and 3 to open and close an exhaust valve, and for an internal combustion engine and 2 make an inlet valve, as for 4, opening and closing [1] and 5 to make an exhaust valve opening and closing, the cam shaft with which 6 is supporting the cam 4 for inlet valves, and 7 are cam shafts which are supporting the cam 5 for exhaust valves. Drawing 3 is the detail drawing of the cam for inlet valves shown in drawing 1 , and a cam shaft. As shown in drawing 3 , the cam profile of the cam 4 of this operation gestalt is changing in the direction of a cam-shaft medial-axis line. that is, the cam 4 of this operation gestalt -- the nose at the left end of drawing 3 -- height -- a right end nose -- it is larger than height. Namely, as for the amount of valve lifts of the inlet valve 2 of this operation gestalt, the direction when the valve lifter is in contact with the right end of a cam 4 becomes small rather than the time of the valve lifter being in contact with the left end of a cam 4.
[0053] It is the amount modification equipment of valve lifts for making explanation of drawing 1 and drawing 2 move a cam 4 in the direction of a cam-shaft medial-axis line to an inlet valve 2, in order that return, the combustion chamber where 8 was formed in the gas column, and 9 may change the amount of valve lifts. That is, by operating the amount modification equipment 9 of valve lifts, in the left end (drawing 3) of a cam 4, a cam 4 and a valve lifter can be contacted or a cam 4 and a valve lifter can be contacted in the right end (drawing 3) of a cam 4. When the amount of valve lifts of an inlet valve 2 is changed by the amount modification equipment 9 of valve lifts, the opening area of an inlet valve 2 will be changed in connection with it. In the inlet valve 2 of this operation gestalt, the opening area of an inlet valve 2 increases as the amount of valve lifts is increased. A driver for 10 to drive the amount modification equipment 9 of valve lifts and 11 are the closing motion timing shifters for shifting the closing motion timing of an inlet valve, without changing the valve-opening period of an inlet valve 2. That is, by operating the closing motion timing shifter 11,

the closing motion timing of an inlet valve 2 can be shifted to a tooth-lead-angle side, or can be shifted to a lag side. 12 is an oil control valve which controls the oil pressure for operating the closing motion timing shifter 11. In addition, both amount modification equipment 9 of valve lifts and closing motion timing shifter 11 will be contained in the good fluctuation valve system in this operation gestalt.

[0054] A sensor for an oil pan mechanism and 15 to detect a fuel injection valve, and for a crankshaft and 14 detect the amount of valve lifts and closing motion timing shift amount of an inlet valve 2 in 13, as for 16 and 17 are the sensors for detecting an engine rotational frequency. An inhalation sky atmospheric temperature sensor for a cooling coolant temperature sensor for a pressure-of-induction-pipe sensor for 18 to detect the pressure within [which supplies inhalation air in a gas column] inhalation of air, and 19 to detect an air flow meter, and for 20 detect the temperature of internal combustion engine cooling water, and 21 to detect the temperature in the inhalation of air within the pipe one of the inhalation air supplied in a gas column, and 22 are ECUs (electronic control). For a cylinder, and 51 and 52, as for a surge tank and 54, an inlet pipe and 53 are [50 / an exhaust pipe and 55] ignition plugs.

[0055] Drawing 4 is detail drawing, such as the amount modification equipment of valve lifts shown in drawing 1 . In drawing 4 , a coil for the magnetic substance with which 30 was connected with the cam shaft 6 for inlet valves, and 31 to energize the magnetic substance 30 on left-hand side, and 32 are the compression spring for energizing the magnetic substance 30 on right-hand side. The amount which a cam 4 and a cam shaft 6 move to left-hand side increases, and the amount of valve lifts of an inlet valve 2 is made to decrease as the amount of energization to a coil 31 is increased.

[0056] Drawing 5 is drawing having shown signs that the amount of valve lifts of an inlet valve changed in connection with the amount modification equipment of valve lifts operating. The amount of valve lifts of an inlet valve 2 is made to increase as are shown in drawing 5 and the amount of energization to a coil 31 decreases (a continuous line -> broken line -> alternate long and short dash line). Moreover, it is made to also change the valve-opening period of an inlet valve 2 with this operation gestalt in connection with the amount modification equipment 9 of valve lifts operating. That is, it is made to also change the working angle of an inlet valve 2. The working angle of an inlet valve 2 is made to increase to a detail in connection with the amount of valve lifts of an inlet valve 2 being made to increase (a continuous line -> broken line -> alternate long and short dash line). Furthermore, it is made to also change the timing from which the amount of valve lifts of an inlet valve 2 serves as a peak with this operation gestalt in connection with the amount modification equipment 9 of valve lifts operating. In connection with the amount of valve lifts of an inlet valve 2 being made to increase, the timing from which the amount of valve lifts of an inlet valve 2 serves as a peak carries out a lag to a detail (a continuous line -> broken line -> alternate long and short dash line).

[0057] Drawing 6 is detail drawing, such as a closing motion timing shifter shown in drawing 1 . In drawing 6 , a lag side cut way for a tooth-lead-angle side cut way for 40 to shift the closing motion timing of an inlet valve 2 to a tooth-lead-angle side and 41 to shift the closing motion timing of an inlet valve 2 to a lag side and 42 are oil pumps. The closing motion timing of an inlet valve 2 is made to shift to a tooth-lead-angle side as the oil pressure in the tooth-lead-angle side cut way 40 is increased. That is, the rotation phase of the cam shaft 6 to a crankshaft 13 carries out a tooth lead angle. On the other hand, the closing motion timing of an inlet valve 2 is made to shift to a lag side as the oil pressure of the lag side cut way 41 is increased. That is, the rotation phase of the cam shaft 6 to a crankshaft 13 carries out a lag.

[0058] Drawing 7 is drawing having shown signs that the closing motion timing of an inlet valve shifted in connection with a closing motion timing shifter operating. The closing motion timing of an inlet valve 2 is shifted to a tooth-lead-angle side as are shown in drawing 7 and the oil pressure in the tooth-lead-angle side cut way 40 is increased (a continuous line -> broken line -> alternate long and short dash line). At this time, the valve-opening period of an inlet valve 2 is not changed, that is, the die length of the period which the inlet valve 2 is opening is not changed.

[0059] If the amount of valve lifts of an inlet valve 2, a working angle, and closing motion timing (phase) are made to change as mentioned above by the amount modification equipment 9 of valve lifts, and the closing motion timing shifter 11, cylinder internal pressure will change in connection

with it. Although cylinder internal pressure changes, if ignition is uniformly performed to predetermined timing, it shifts from the optimal ignition timing and an internal combustion engine cannot be controlled appropriately. Therefore, in order to light to the optimal timing and to control an internal combustion engine appropriately, it is necessary to compute correctly the amount of valve lifts of an inlet valve 2, a working angle, and the cylinder internal pressure that changes with modification of closing motion timing (phase).

[0060] Drawing 8 is the flow chart which showed the ignition timing calculation approach in this operation gestalt. This routine is performed at intervals of predetermined time. If this routine is started as shown in drawing 8 , in step 100, it will be judged first whether it is at the engine starting time. At the time of YES, at the time of engine starting to which fuel increase in quantity is carried out, cylinder internal pressure is computed correctly, it judges that it is not necessary to determine ignition timing based on it, and this routine is ended. On the other hand, it progresses to step 101 at the time of NO. At step 101, the cylinder internal pressure reference condition PCYLb is computed based on the pressure PM and the engine rotational frequency NE the amount LT of valve lifts, the working angle VA, the closing motion timing VT, and within inhalation of air of an inlet valve 2 at the time of a compression top dead center.

[0061] Drawing 9 is drawing having shown the relation between the cylinder internal pressure standard condition PCYLb, the amount LT of valve lifts, and the pressure PM within inhalation of air at the time of a compression top dead center. As shown in drawing 9 , the cylinder internal pressure standard condition PCYLb becomes high at the time of the compression top dead center computed in step 101 as it becomes high as the amount LT of valve lifts becomes large, and the pressure PM within inhalation of air becomes high. Drawing 10 is drawing having shown the relation between the cylinder internal pressure reference condition PCYLb, the working angle VA, and the pressure PM within inhalation of air at the time of a compression top dead center. As shown in drawing 10 , when an inlet valve 2 carries out the close by-pass bulb completely of the cylinder internal pressure reference condition PCYLb after an inhalation-of-air bottom dead point, it becomes high at the time of the compression top dead center computed in step 101 as the working angle VA becomes small. Drawing 11 is drawing having shown the relation between the cylinder internal pressure reference condition PCYLb, the working angle VA, and the pressure PM within inhalation of air at the time of a compression top dead center. As shown in drawing 11 , when an inlet valve 2 carries out the close by-pass bulb completely of the cylinder internal pressure reference condition PCYLb before an inhalation-of-air bottom dead point, it becomes high at the time of the compression top dead center computed in step 101 as the working angle VA becomes large.

[0062] Drawing 12 is drawing having shown relation with the pressure PM the cylinder internal pressure reference condition PCYLb, the closing motion timing (phase) VT, and within inhalation of air at the time of a compression top dead center. As shown in drawing 12 , when an inlet valve 2 carries out the close by-pass bulb completely of the cylinder internal pressure reference condition PCYLb after an inhalation-of-air bottom dead point, it becomes high at the time of the compression top dead center computed in step 101 as the closing motion timing (phase) VT carries out a tooth lead angle. Drawing 13 is drawing having shown relation with the pressure PM the cylinder internal pressure reference condition PCYLb, the closing motion timing (phase) VT, and within inhalation of air at the time of a compression top dead center. As shown in drawing 13 , when an inlet valve 2 carries out the close by-pass bulb completely of the cylinder internal pressure reference condition PCYLb before an inhalation-of-air bottom dead point, it becomes high at the time of the compression top dead center computed in step 101 as the closing motion timing (phase) VT carries out a lag. Drawing 14 is drawing having shown the relation between the cylinder internal pressure reference condition PCYLb and the engine rotational frequency NE at the time of a compression top dead center. As shown in drawing 14 , the cylinder internal pressure reference condition PCYLb serves as a peak at the time of the compression top dead center computed in step 101, when the engine rotational frequency NE is medium speed.

[0063] Based on the return and engine service condition of the present in step 102 subsequently the cylinder internal pressure PCYL is computed by explanation of drawing 8 from the cylinder internal pressure reference condition PCYLb at the time of a compression top dead center at the time of a compression top dead center. Subsequently, at step 103, ignition timing SA is computed based on the

cylinder internal pressure PCYL, the engine rotational frequency NE, and the inhalation air content GN GN inhaled in a gas column per rotation, i.e., the inhalation air content which sets like 1 time of an inhalation-of-air line, and is inhaled in a gas column, at the time of a compression top dead center. Drawing 15 is drawing having shown the relation between the cylinder internal pressure PCYL and the inhalation air content GN inhaled in a gas column per rotation at the time of ignition timing SA and a compression top dead center. As shown in drawing 15 , the lag of the ignition timing SA computed in step 103 is carried out as the cylinder internal pressure PCYL becomes high at the time of a compression top dead center, and the lag of it is carried out as the inhalation air content GN inhaled in a gas column per rotation increases. Drawing 16 is drawing having shown the relation between ignition timing SA and the engine rotational frequency NE. The tooth lead angle of the ignition timing SA computed in step 103 is carried out as are shown in drawing 16 , and the engine rotational frequency NE becomes high.

[0064] As mentioned above, in step 101 and step 102 of drawing 8 , cylinder internal pressure (at the time of a compression top dead center cylinder internal pressure PCYL) is computed based on the opening area of the inlet valve 2 you are made to change in connection with the amount LT of valve lifts being changed by the amount modification equipment 9 of valve lifts as a good fluctuation valve system, and an internal combustion engine is controlled by this operation gestalt based on the cylinder internal pressure. Therefore, unlike the case where cylinder internal pressure is detected, not only based on the cylinder internal pressure of a combustion pressure peak period but the cylinder internal pressure at the times other than a combustion pressure peak period, an internal combustion engine is controllable by the cylinder internal pressure sensor according to this operation gestalt like an internal combustion engine's control unit indicated by JP,9-53503,A. Furthermore, even if it is the case where the opening area of an inlet valve 2 is made to change, an internal combustion engine is appropriately controllable. as shown in drawing 9 , the cylinder internal pressure which the opening area of an inlet valve 2 increases and which is alike, follows and is computed based on the opening area of an inlet valve increases to a detail, and as shown in drawing 15 , cylinder internal pressure increases to it -- an internal combustion engine is controlled so that it is alike, and it follows and ignition timing SA carries out a lag.

[0065] Furthermore, in step 101 and step 102 of drawing 8 , cylinder internal pressure (at the time of a compression top dead center cylinder internal pressure PCYL) is computed based on the working angle VA of the inlet valve 2 you are made to change with the amount modification equipment 9 of valve lifts as a good fluctuation valve system, and an internal combustion engine is controlled by this operation gestalt based on the cylinder internal pressure. Therefore, unlike the case where cylinder internal pressure is detected, not only based on the cylinder internal pressure of a combustion pressure peak period but the cylinder internal pressure at the times other than a combustion pressure peak period, an internal combustion engine is controllable by the cylinder internal pressure sensor according to this operation gestalt like an internal combustion engine's control unit indicated by JP,9-53503,A. Furthermore, even if it is the case where the working angle VA of an inlet valve 2 is made to change, an internal combustion engine is appropriately controllable. the cylinder internal pressure to which the working angle VA of an inlet valve 2 decreases and which is alike, follows and is computed based on the working angle VA of an inlet valve 2 increases to a detail, and as shown in drawing 10 , when an inlet valve 2 carries out a close by-pass bulb completely after an inhalation-of-air bottom dead point, as shown in drawing 15 , cylinder internal pressure increases to it -- an internal combustion engine is controlled so that it is alike, and it follows and ignition timing SA carries out a lag. moreover, as shown in drawing 11 , when an inlet valve 2 carries out a close by-pass bulb completely before an inhalation-of-air bottom dead point, the cylinder internal pressure which the working angle VA of an inlet valve 2 increases and which is alike, follows and is computed based on the working angle VA of an inlet valve 2 increases, and as shown in drawing 15 , cylinder internal pressure increases -- an internal combustion engine is controlled so that it is alike, and it follows and ignition timing SA carries out a lag.

[0066] Moreover, in step 101 and step 102 of drawing 8 , cylinder internal pressure (at the time of a compression top dead center cylinder internal pressure PCYL) is computed based on both the opening area of the inlet valve 2 you are made to change with the amount modification equipment 9 of valve lifts as a good fluctuation valve system, and the working angle VA, and an internal

combustion engine is controlled by this operation gestalt based on the cylinder internal pressure. Therefore, according to this operation gestalt, rather than the case where cylinder internal pressure is computed only based on the opening area of an inlet valve 2, without being based on the working angle VA of an inlet valve 2, and the case where cylinder internal pressure is computed based on the working angle VA of an inlet valve 2, without being based on the opening area of an inlet valve 2, cylinder internal pressure can be computed correctly and an internal combustion engine can be controlled appropriately.

[0067] Moreover, in step 101 and step 102 of drawing 8 , cylinder internal pressure (at the time of a compression top dead center cylinder internal pressure PCYL) is computed based on the pressure PM and the engine rotational frequency NE the closing motion timing (phase) VT and within inhalation of air of an inlet valve 2, and an internal combustion engine is controlled by this operation gestalt based on the cylinder internal pressure. Therefore, according to this operation gestalt, rather than the case where cylinder internal pressure is not computed based on the pressure PM and the engine rotational frequency NE the closing motion timing (phase) VT and within inhalation of air of an inlet valve 2, cylinder internal pressure can be computed correctly and an internal combustion engine can be controlled appropriately.

[0068] In addition, although cylinder internal pressure is computed based on the opening area of an inlet valve etc. and the internal combustion engine is controlled by this operation gestalt based on the cylinder internal pressure, it is also possible to compute cylinder internal pressure based on the opening area of an exhaust valve etc., and to control an internal combustion engine by other operation gestalten based on the cylinder internal pressure. That is, this invention is applicable not only to an inlet valve but an exhaust valve.

[0069] Hereafter, the second operation gestalt of the control unit of the internal combustion engine of this invention is explained. The configuration of this operation gestalt is the same as the configuration of the first operation gestalt shown in drawing 1 - drawing 7 almost. Also in this operation gestalt, if the amount of valve lifts of an inlet valve 2, a working angle, and closing motion timing (phase) are made to change by the amount modification equipment 9 of valve lifts, and the closing motion timing shifter 11, cylinder internal pressure will change in connection with it. Although cylinder internal pressure changes, if fuel oil consumption is defined uniformly, an actual air-fuel ratio shifts from a target air-fuel ratio, and cannot control an internal combustion engine appropriately. Therefore, in order to compute the optimal fuel oil consumption and to control an internal combustion engine appropriately, it is necessary to compute correctly the amount of valve lifts of an inlet valve 2, a working angle, and the cylinder internal pressure that changes with modification of closing motion timing (phase).

[0070] Drawing 17 is the flow chart which showed the fuel-oil-consumption calculation approach in this operation gestalt. This routine is performed at intervals of predetermined time. If this routine is started as shown in drawing 17 , in step 200, it will be judged first whether it is at the engine starting time. At the time of YES, since fuel oil consumption becomes settled regardless of cylinder internal pressure at the time of engine starting to which fuel increase in quantity is carried out, in order to determine fuel oil consumption, it judges that cylinder internal pressure does not need to compute correctly, and this routine is ended. On the other hand, it progresses to step 201 at the time of NO. At step 201, the cylinder internal pressure reference condition PCYLINb is computed based on the pressure PM and the engine rotational frequency NE the amount LT of valve lifts, the working angle VA, the closing motion timing VT, and within inhalation of air of an inlet valve 2 at the time of an inhalation-of-air bottom dead point.

[0071] Drawing 18 is drawing having shown the relation between the cylinder internal pressure standard condition PCYLINb, the amount LT of valve lifts, and the pressure PM within inhalation of air at the time of an inhalation-of-air bottom dead point. As shown in drawing 18 , the cylinder internal pressure standard condition PCYLINb becomes high at the time of the inhalation-of-air bottom dead point computed in step 201 as it becomes high as the amount LT of valve lifts becomes large, and the pressure PM within inhalation of air becomes high. Drawing 19 is drawing having shown the relation between the cylinder internal pressure reference condition PCYLINb, the working angle VA, and the pressure PM within inhalation of air at the time of an inhalation-of-air bottom dead point. As shown in drawing 19 , the cylinder internal pressure reference condition PCYLINb

becomes high at the time of the inhalation-of-air bottom dead point computed in step 201 as the working angle VA becomes small.
[0072] Drawing 20 is drawing having shown relation with the pressure PM the cylinder internal pressure reference condition PCYLINb, the closing motion timing (phase) VT, and within inhalation of air at the time of an inhalation-of-air bottom dead point. As shown in drawing 20 , it becomes high at the time of the inhalation-of-air bottom dead point computed in step 201 as the closing motion timing (phase) VT carries out the tooth lead angle of the cylinder internal pressure reference condition PCYLINb. Drawing 21 is drawing having shown the relation between the cylinder internal pressure reference condition PCYLINb and the engine rotational frequency NE at the time of an inhalation-of-air bottom dead point. As shown in drawing 21 , the cylinder internal pressure reference condition PCYLINb serves as a peak at the time of the inhalation-of-air bottom dead point computed in step 201, when the engine rotational frequency NE is medium speed.
[0073] Based on the return and engine service condition of the present in step 202 subsequently the cylinder internal pressure PCYLIN is computed by explanation of drawing 17 from the cylinder internal pressure reference condition PCYLINb at the time of an inhalation-of-air bottom dead point at the time of an inhalation-of-air bottom dead point. Subsequently, at step 203, fuel oil consumption QINJ is computed based on the cylinder internal pressure PCYLIN and the closing motion timing (a phase, bulb overlap) VT at the time of an inhalation-of-air bottom dead point. Drawing 22 is drawing having shown the cylinder internal pressure PCYLIN and relation with the closing motion timing (a phase, bulb overlap) VT at the time of fuel oil consumption QINJ and an inhalation-of-air bottom dead point. The fuel oil consumption QINJ computed in step 203 is made to increase as the cylinder internal pressure PCYLIN becomes high at the time of an inhalation-of-air bottom dead point, and it is made to increase, as shown in drawing 22 as the lag of the closing motion timing (phase) VT is carried out (i.e., as the bulb overlap period of an inlet valve 2 and an exhaust valve 3 decreases).
[0074] As mentioned above, in step 201 and step 202 of drawing 17 , cylinder internal pressure (at the time of an inhalation-of-air bottom dead point cylinder internal pressure PCYLIN) is computed based on the opening area of the inlet valve 2 you are made to change in connection with the amount LT of valve lifts being changed by the amount modification equipment 9 of valve lifts as a good fluctuation valve system, and an internal combustion engine is controlled by this operation gestalt based on the cylinder internal pressure. Therefore, unlike the case where cylinder internal pressure is detected, not only based on the cylinder internal pressure of a combustion pressure peak period but the cylinder internal pressure at the times other than a combustion pressure peak period, an internal combustion engine is controllable by the cylinder internal pressure sensor according to this operation gestalt like an internal combustion engine's control unit indicated by JP,9-53503,A. Furthermore, even if it is the case where the opening area of an inlet valve 2 is made to change, an internal combustion engine is appropriately controllable. as shown in drawing 18 , the cylinder internal pressure which the opening area of an inlet valve 2 increases and which is alike, follows and is computed based on the opening area of an inlet valve increases to a detail, and as shown in drawing 22 , cylinder internal pressure increases to it -- an internal combustion engine is controlled so that are alike, and it follows and fuel oil consumption QINJ is made to increase.
[0075] Furthermore, in step 201 and step 202 of drawing 17 , cylinder internal pressure (at the time of an inhalation-of-air bottom dead point cylinder internal pressure PCYLIN) is computed based on the working angle VA of the inlet valve 2 you are made to change with the amount modification equipment 9 of valve lifts as a good fluctuation valve system, and an internal combustion engine is controlled by this operation gestalt based on the cylinder internal pressure. Therefore, unlike the case where cylinder internal pressure is detected, not only based on the cylinder internal pressure of a combustion pressure peak period but the cylinder internal pressure at the times other than a combustion pressure peak period, an internal combustion engine is controllable by the cylinder internal pressure sensor according to this operation gestalt like an internal combustion engine's control unit indicated by JP,9-53503,A. Furthermore, even if it is the case where the working angle VA of an inlet valve 2 is made to change, an internal combustion engine is appropriately controllable. as shown in drawing 19 , the cylinder internal pressure to which the working angle VA of an inlet valve 2 decreases and which is alike, follows and is computed based on the working angle VA of an inlet valve 2 increases to a detail, and as shown in drawing 22 , cylinder internal pressure

increases to it -- an internal combustion engine is controlled so that are alike, and it follows and fuel oil consumption QINJ is made to increase.
[0076] Moreover, in step 201 and step 202 of drawing 17 , cylinder internal pressure (at the time of an inhalation-of-air bottom dead point cylinder internal pressure PCYLIN) is computed based on both the opening area of the inlet valve 2 you are made to change with the amount modification equipment 9 of valve lifts as a good fluctuation valve system, and the working angle VA, and an internal combustion engine is controlled by this operation gestalt based on the cylinder internal pressure. Therefore, according to this operation gestalt, rather than the case where cylinder internal pressure is computed only based on the opening area of an inlet valve 2, without being based on the working angle VA of an inlet valve 2, and the case where cylinder internal pressure is computed based on the working angle VA of an inlet valve 2, without being based on the opening area of an inlet valve 2, cylinder internal pressure can be computed correctly and an internal combustion engine can be controlled appropriately.
[0077] Moreover, in step 201 and step 202 of drawing 17 , cylinder internal pressure (at the time of an inhalation-of-air bottom dead point cylinder internal pressure PCYLIN) is computed based on the pressure PM and the engine rotational frequency NE the closing motion timing (phase) VT and within inhalation of air of an inlet valve 2, and an internal combustion engine is controlled by this operation gestalt based on the cylinder internal pressure. Therefore, according to this operation gestalt, rather than the case where cylinder internal pressure is not computed based on the pressure PM and the engine rotational frequency NE the closing motion timing (phase) VT and within inhalation of air of an inlet valve 2, cylinder internal pressure can be computed correctly and an internal combustion engine can be controlled appropriately.
[0078] In addition, although cylinder internal pressure is computed based on the opening area of an inlet valve etc. and the internal combustion engine is controlled by this operation gestalt based on the cylinder internal pressure, it is also possible to compute cylinder internal pressure based on the opening area of an exhaust valve etc., and to control an internal combustion engine by other operation gestalten based on the cylinder internal pressure. That is, this invention is applicable not only to an inlet valve but an exhaust valve.
[0079] Hereafter, the third operation gestalt of the control unit of the internal combustion engine of this invention is explained. The configuration of this operation gestalt is the same as the configuration of the first operation gestalt shown in drawing 1 - drawing 7 almost. If the amount of valve lifts of an inlet valve 2, a working angle, and closing motion timing (phase) are made to change by the amount modification equipment 9 of valve lifts, and the closing motion timing shifter 11, the gas temperature in a cylinder will change in connection with it. Although the gas temperature in a cylinder changes, if ignition is uniformly performed to predetermined timing, it shifts from the optimal ignition timing and an internal combustion engine cannot be controlled appropriately. Therefore, in order to light to the optimal timing and to control an internal combustion engine appropriately, it is necessary to compute correctly the amount of valve lifts of an inlet valve 2, a working angle, and the gas temperature in a cylinder that changes with modification of closing motion timing (phase).
[0080] Drawing 23 is the flow chart which showed the ignition timing calculation approach in this operation gestalt. This routine is performed at intervals of predetermined time. If this routine is started as shown in drawing 23 , in step 300, it will be judged first whether it is at the engine starting time. At the time of YES, at the time of engine starting to which fuel increase in quantity is carried out, the gas temperature in a cylinder is computed correctly, it judges that it is not necessary to determine ignition timing based on it, and this routine is ended. On the other hand, it progresses to step 301 at the time of NO. At step 301, the gas-temperature reference condition TCYLb in a cylinder is computed based on the pressure PM and the engine rotational frequency NE the amount LT of valve lifts, the working angle VA, the closing motion timing VT, and within inhalation of air of an inlet valve 2 at the time of a compression top dead center.
[0081] Drawing 24 is drawing having shown the gas-temperature standard condition TCYLb in a cylinder, the amount LT of valve lifts, and relation with the closing motion timing (phase) VT at the time of a compression top dead center. At the time of the compression top dead center computed in step 301, the gas-temperature standard condition TCYLb in a cylinder becomes high as the amount

LT of valve lifts becomes large, and as shown in drawing 24 , when an inlet valve 2 carries out a close by-pass bulb completely after an inhalation-of-air bottom dead point, it becomes high as the tooth lead angle of the closing motion timing (phase) VT is carried out. At the time of the compression top dead center computed in step 301, the gas-temperature standard condition TCYLb in a cylinder becomes high as the amount LT of valve lifts becomes large, and as shown in drawing 25 , when an inlet valve 2 carries out a close by-pass bulb completely before an inhalation-of-air bottom dead point, it becomes high as the lag of the closing motion timing (phase) VT is carried out. Drawing 26 is drawing having shown the relation between the gas-temperature standard condition TCYLb in a cylinder, the amount LT of valve lifts, and the working angle VA at the time of a compression top dead center. As shown in drawing 26 , when an inlet valve 2 carries out the close by-pass bulb completely of the gas-temperature reference condition TCYLb in a cylinder after an inhalation-of-air bottom dead point, it becomes high at the time of the compression top dead center computed in step 301 as the working angle VA becomes large. Drawing 27 is drawing having shown the relation between the gas-temperature standard condition TCYLb in a cylinder, the amount LT of valve lifts, and the working angle VA at the time of a compression top dead center. As shown in drawing 27 , when an inlet valve 2 carries out the close by-pass bulb completely of the gas-temperature reference condition TCYLb in a cylinder before an inhalation-of-air bottom dead point, it becomes high at the time of the compression top dead center computed in step 301 as the working angle VA becomes small.

[0082] Drawing 28 is drawing having shown relation with the pressure PM the gas-temperature reference condition TCYLb in a cylinder, and within inhalation of air at the time of a compression top dead center. As shown in drawing 28 , the gas-temperature reference condition TCYLb in a cylinder becomes high at the time of the compression top dead center computed in step 301 as the pressure PM within inhalation of air becomes high. As shown in drawing 29 , the gas-temperature reference condition TCYLb in a cylinder serves as a peak at the time of the compression top dead center computed in step 301, when the engine rotational frequency NE is medium speed.

[0083] The return and heat-receiving correction value KTWALL based on [subsequently] cylinder wall ** Twall at step 302 is computed by explanation of drawing 23 . Cylinder wall ** Twall is presumed based on the following formula.

Twall=(K1xGa(i)-Tw(i)-Twall (i-1)) xK2+Twall (i)

[0084] A value when the routine which shows the inhalation air content by which K1 was computed by basing a combustion correction factor and K2 on a response coefficient, and basing Ga on the output value of an air flow meter 19, and Tw to engine cooling water temperature here, and shows i to drawing 23 is performed this time, and i-1 are values when the routine shown in drawing 23 is performed last time. The combustion correction factor K1 becomes a forward value when the fuel injected from the fuel injection valve 15 has burned, and a fuel cut is performed and it becomes a negative value at the time of motoring in which the fuel has not burned. Drawing 30 is drawing having shown difference with the gas-temperature reference condition TCYLb in a cylinder, and relation with the engine rotational frequency NE at the time of the heat-receiving correction value KTWALL, cylinder wall ** Twall, and a compression top dead center. As shown in drawing 30 , the heat-receiving correction value KTWALL becomes large as it becomes large as cylinder wall ** Twall becomes high from the gas-temperature reference condition TCYLb in a cylinder at the time of a compression top dead center, and the engine rotational frequency NE becomes low.

[0085] Subsequently to in a gas column, inhalation sky atmospheric temperature change correction value KTIN based on return and inhalation sky atmospheric temperature inhaled at step 303 is computed by explanation of drawing 23 . Drawing 31 is drawing having shown the relation between inhalation sky atmospheric temperature change correction value KTIN, the engine cooling water temperature Tw, and the inhalation air content Ga. As shown in drawing 31 , inhalation sky atmospheric temperature change correction value KTIN becomes large as the engine cooling water temperature Tw becomes high, and it becomes large as the inhalation air content Ga decreases.

[0086] The internal EGR gas temperature-change correction value KTEGR based on the return and interior-subsequently EGR gas rate in a gas column in step 304 is computed by explanation of drawing 23 . Drawing 32 is drawing having shown the relation between the internal EGR gas temperature-change correction value KTEGR and an internal EGR gas rate. As shown in drawing

32 , the internal EGR gas temperature-change correction value KTEGR becomes large as an internal EGR gas rate becomes high. It is also possible to compute the internal EGR gas temperature-change correction value KTEGR in the modification of this operation gestalt based on the amount of internal EGR gas. In that case, it becomes large as the amount of internal EGR gas of internal EGR gas temperature-change correction value KTEGR increases. It is also possible to compute the internal EGR gas temperature-change correction value KTEGR in other modifications of this operation gestalt based on the last ignition timing and the amount of combustion products per last rotation. Drawing 33 is drawing having shown the relation between the internal EGR gas temperature-change correction value KTEGR, the last ignition timing, and the amount of combustion products per last rotation. As shown in drawing 33 , the internal EGR gas temperature-change correction value KTEGR becomes large as the lag of the last ignition timing is carried out, and it becomes large as the amount of combustion products per last rotation increases. It is also possible to compute the internal EGR gas temperature-change correction value KTEGR in the modification of further others of this operation gestalt based on the last air-fuel ratio. Drawing 34 is drawing having shown the relation between the internal EGR gas temperature-change correction value KTEGR and the last air-fuel ratio. As shown in drawing 34 , even if the internal EGR gas temperature-change correction value KTEGR serves as a peak in an air-fuel ratio a little more rich than SUTOIKI, and becomes rich rather than it and it becomes Lean, it becomes small.

[0087] Gas-temperature TCYL in a cylinder is computed by explanation of drawing 23 at the time of a compression top dead center based on the heat-receiving correction value KTWALL computed in the gas-temperature reference condition TCYLb in a cylinder, and step 302 at the time of the return and compression top dead center computed [in / subsequently / at step 305 / step 301], and inhalation sky atmospheric-temperature change correction value KTIN computed in step 303 and the internal EGR gas temperature-change correction value KTEGR computed in step 304 (TCYL<-TCYLbxKTWALLxKTINxKTEGR). Subsequently, at step 306, ignition timing SA is computed based on gas-temperature TCYL in a cylinder, the inhalation air content GN per rotation, and the engine rotational frequency NE at the time of a compression top dead center. Drawing 35 is drawing having shown the relation between gas-temperature TCYL in a cylinder, and the inhalation air content GN per rotation at the time of ignition timing SA and a compression top dead center. As shown in drawing 35 , the lag of the ignition timing SA computed in step 306 is carried out as gas-temperature TCYL in a cylinder becomes high at the time of a compression top dead center, and the lag of it is carried out as the inhalation air content GN per rotation increases. Moreover, the tooth lead angle of the ignition timing SA computed in step 306 is carried out as were shown in drawing 16 , and the engine rotational frequency NE becomes high.

[0088] As mentioned above, in step 301 and step 305 of drawing 23 , the gas temperature in a cylinder (at the time of a compression top dead center gas-temperature TCYL in a cylinder) is computed based on the opening area of the inlet valve 2 you are made to change in connection with the amount LT of valve lifts being changed by the amount modification equipment 9 of valve lifts as a good fluctuation valve system, and an internal combustion engine is controlled by this operation gestalt based on the gas temperature in the cylinder. Therefore, according to this operation gestalt, an internal combustion engine is appropriately controllable from the case where an internal combustion engine is controlled based on cylinder wall ** like an internal combustion engine's control unit indicated by JP,4-81574,A. Furthermore, even if it is the case where the opening area of an inlet valve 2 is made to change, an internal combustion engine is appropriately controllable. An internal combustion engine is controlled by the detail so that ignition timing SA carries out a lag, as the gas temperature in a cylinder which the opening area of an inlet valve 2 increases and which is alike, therefore is computed based on the opening area of an inlet valve becomes high as shown in drawing 24 and drawing 25 , and were shown in drawing 35 and the gas temperature in a cylinder becomes high.

[0089] Furthermore, in step 301 and step 305 of drawing 23 , the gas temperature in a cylinder (at the time of a compression top dead center gas-temperature TCYL in a cylinder) is computed based on the working angle VA of the inlet valve 2 you are made to change with the amount modification equipment 9 of valve lifts as a good fluctuation valve system, and an internal combustion engine is controlled by this operation gestalt based on the gas temperature in the cylinder. Therefore,

according to this operation gestalt, an internal combustion engine is appropriately controllable from the case where an internal combustion engine is controlled based on cylinder wall ** like an internal combustion engine's control unit indicated by JP,4-81574,A. Furthermore, even if it is the case where the working angle VA of an inlet valve 2 is made to change, an internal combustion engine is appropriately controllable. the gas temperature in a cylinder which the working angle VA of an inlet valve 2 increases to a detail when an inlet valve 2 carries out a close by-pass bulb completely after an inhalation-of-air bottom dead point, as shown in drawing 26 and which is alike, follows and is computed based on the working angle VA of an inlet valve 2 becomes high, and as shown in drawing 35 , the gas temperature in a cylinder becomes high -- an internal combustion engine is controlled so that it is alike, and it follows and ignition timing SA carries out a lag. moreover, as shown in drawing 27 , when an inlet valve 2 carries out a close by-pass bulb completely before an inhalation-of-air bottom dead point, the gas temperature in a cylinder to which the working angle VA of an inlet valve 2 decreases and which is alike, follows and is computed based on the working angle VA of an inlet valve 2 becomes high, and as shown in drawing 35 , the gas temperature in a cylinder becomes high -- an internal combustion engine is controlled so that it is alike, and it follows and ignition timing SA carries out a lag.

[0090] Moreover, in step 301 and step 305 of drawing 23 , the gas temperature in a cylinder (at the time of a compression top dead center gas-temperature TCYL in a cylinder) is computed based on both the opening area of the inlet valve 2 you are made to change with the amount modification equipment 9 of valve lifts as a good fluctuation valve system, and the working angle VA, and an internal combustion engine is controlled by this operation gestalt based on the gas temperature in the cylinder. Therefore, according to this operation gestalt, rather than the case where the gas temperature in a cylinder is computed only based on the opening area of an inlet valve 2, without being based on the working angle VA of an inlet valve 2, and the case where the gas temperature in a cylinder is computed based on the working angle VA of an inlet valve 2, without being based on the opening area of an inlet valve 2, the gas temperature in a cylinder can be computed correctly and an internal combustion engine can be controlled appropriately.

[0091] Moreover, in step 301 and step 305 of drawing 23 , the gas temperature in a cylinder (at the time of a compression top dead center gas-temperature TCYL in a cylinder) is computed based on the pressure PM and the engine rotational frequency NE the closing motion timing (phase) VT and within inhalation of air of an inlet valve 2, and an internal combustion engine is controlled by this operation gestalt based on the gas temperature in the cylinder. Therefore, according to this operation gestalt, rather than the case where the gas temperature in a cylinder is not computed based on the pressure PM and the engine rotational frequency NE the closing motion timing (phase) VT and within inhalation of air of an inlet valve 2, the gas temperature in a cylinder can be computed correctly and an internal combustion engine can be controlled appropriately.

[0092] Moreover, with this operation gestalt, in step 302 of drawing 23 , the gas temperature in a cylinder is amended based on cylinder wall ** Twall and the engine rotational frequency NE, the gas temperature in a cylinder is amended based on the inhalation air content Ga in step 303, and the gas temperature in a cylinder is further amended based on the amount of internal EGR gas (internal EGR gas rate), i.e., the internal EGR gas temperature which changes in response to the effect, in step 304. Therefore, according to this operation gestalt, an internal combustion engine is appropriately controllable from the case where the gas temperature in a cylinder is not amended based on them.

[0093] In addition, although the gas temperature in a cylinder is computed based on the opening area of an inlet valve etc. and the internal combustion engine is controlled by this operation gestalt based on the gas temperature in the cylinder, it is also possible to compute the gas temperature in a cylinder based on the opening area of an exhaust valve etc., and to control an internal combustion engine by other operation gestalten based on the gas temperature in the cylinder. That is, this invention is applicable not only to an inlet valve but an exhaust valve.

[0094] Hereafter, the fourth operation gestalt of the control unit of the internal combustion engine of this invention is explained. The configuration of this operation gestalt is the same as the configuration of the first operation gestalt shown in drawing 1 - drawing 7 almost. If the amount of valve lifts of an inlet valve 2, a working angle, and closing motion timing (phase) are made to change by the amount modification equipment 9 of valve lifts, and the closing motion timing shifter

11, it will follow on it and the internal EGR gas rate in a gas column will change. Although an internal EGR gas rate changes, if ignition is uniformly performed to predetermined timing, it shifts from the optimal ignition timing and an internal combustion engine cannot be controlled appropriately. Therefore, in order to light to the optimal timing and to control an internal combustion engine appropriately, it is necessary to compute correctly the amount of valve lifts of an inlet valve 2, a working angle, and the internal EGR gas rate of changing with modification of closing motion timing (phase).
[0095] Drawing 36 is the flow chart which showed the ignition timing calculation approach in this operation gestalt. This routine is performed at intervals of predetermined time. If this routine is started as shown in drawing 36 , in step 400, it will be judged first whether it is at the engine starting time. At the time of YES, at the time of engine starting to which fuel increase in quantity is carried out, an internal EGR gas rate is computed correctly, it judges that it is not necessary to determine ignition timing based on it, and this routine is ended. On the other hand, it progresses to step 401 at the time of NO. At step 401, the internal EGR gas rate reference condition stationary value KEGRb is computed based on the pressure PM and the engine rotational frequency NE the amount LT of valve lifts, the working angle VA, the closing motion timing VT, and within inhalation of air of an inlet valve 2.
[0096] Drawing 37 is drawing having shown the internal EGR gas rate standard-condition stationary value KEGRb, the amount LT of valve lifts, and relation with the closing motion timing (phase) VT. As shown in drawing 37 , the internal EGR gas rate standard-condition stationary value KEGRb computed in step 401 becomes large as the amount LT of valve lifts becomes large, and it becomes large as the tooth lead angle of the closing motion timing (phase) VT is carried out. Drawing 38 is drawing having shown the internal EGR gas rate reference condition stationary value KEGRb, the working angle VA, and relation with the closing motion timing (phase) VT. As shown in drawing 38 , the internal EGR gas rate reference condition stationary value KEGRb computed in step 401 becomes large as the working angle VA becomes large.
[0097] Drawing 39 is drawing having shown the relation between the internal EGR gas rate reference condition stationary value KEGRb and the pressure PM within inhalation of air. As shown in drawing 39 , the internal EGR gas rate reference condition stationary value KEGRb computed in step 401 becomes small as the pressure PM within inhalation of air becomes high. As shown in drawing 40 , the internal EGR gas rate reference condition stationary value KEGRb computed in step 401 becomes small as the engine rotational frequency NE becomes high.
[0098] It returns to explanation of drawing 36 and, subsequently the internal EGR gas rate stationary value KEGRST is computed at step 402 based on the internal EGR gas rate reference condition stationary value KEGRb and the atmospheric pressure correction factor KPA (KEGRST<-KEGRbxKPA). That is, an internal EGR gas rate is amended in consideration of atmospheric pressure. Drawing 41 is drawing having shown the relation between the atmospheric pressure correction factor KPA and atmospheric pressure. As shown in drawing 41 , the atmospheric pressure correction factor KPA becomes large as atmospheric pressure becomes high. That is, an internal EGR gas rate becomes so high that atmospheric pressure becomes high. It is also possible to compute a correction factor based on back pressure, and to amend an internal EGR gas rate based on the correction factor instead of computing a correction factor KPA in the modification of this operation gestalt, based on atmospheric pressure, as shown in drawing 41 . Drawing 42 is drawing having shown the relation between back pressure, the engine rotational frequency NE, and the inhalation air content GN per rotation. As shown in drawing 42 , back pressure becomes high as the engine rotational frequency NE becomes high, and it becomes high as the inhalation air content GN per rotation increases. Drawing 43 is drawing having shown the relation between the back pressure correction factor for amending an internal EGR gas rate, and back pressure. As shown in drawing 43 , a back pressure correction factor becomes large as back pressure becomes high. That is, an internal EGR gas rate becomes so high that back pressure becomes high.
[0099] moreover, after being blown in the step of step 402 of drawing 36 which is not illustrated [of a degree] in the modification of this operation gestalt within inhalation of air, it is also possible to amend the internal EGR gas rate stationary value KEGRST based on the amount (the following -- "-- for it to blow and to be called capacity") of the burnt gas again inhaled in a gas column. Drawing 44

is drawing in which having blown over and having shown the relation between capacity, an average opening area (average value of the opening area of the inlet valve in a bulb overlap period) of an inlet valve 2, and average inlet-valve 2 order differential pressure (average value of the difference of the cylinder internal pressure in a bulb overlap period, and the pressure within inhalation of air). As shown in drawing 44 , it blows, capacity increases as the opening area of an inlet valve 2 becomes large, and it increases as inlet-valve order differential pressure becomes large (i.e., as cylinder internal pressure becomes higher than the pressure within inhalation of air). Drawing 45 is drawing in which having blown over with the internal EGR gas rate stationary value KEGRST, and having shown relation with capacity. As shown in drawing 45 , the internal EGR gas rate stationary value KEGRST becomes large as it is blown and its capacity increases. That is, the internal EGR gas rate stationary value KEGRST becomes large as it becomes large as the opening area of an inlet valve 2 becomes large, and cylinder internal pressure becomes higher than the pressure within inhalation of air. The opening area of the inlet valve 2 in the bulb overlap period you are made to change by the good fluctuation valve system according to this modification, Since an internal EGR gas rate is computed based on the pressure (cylinder internal pressure) of the downstream of the inlet valve 2 in a bulb overlap period, and the pressure (pressure within inhalation of air) of the upstream and an internal combustion engine is controlled based on the internal EGR gas rate, An internal EGR gas rate is computed only based on the opening area of the inlet valve 2 you are made to change by the good fluctuation valve system. Rather than the case where an internal EGR gas rate is not computed based on the pressure of the downstream of the inlet valve in a bulb overlap period, and the pressure of the upstream, an internal EGR gas rate can be computed correctly and an internal combustion engine can be controlled appropriately.

[0100] In the further modification of this modification, moreover, instead of the average value of the opening area of the inlet valve in a bulb overlap period, and the average value of the difference of the cylinder internal pressure in a bulb overlap period, and the pressure within inhalation of air Based on the opening area for every predetermined time in a bulb overlap period, and the difference of the cylinder internal pressure (pressure of the downstream of an inlet valve 2) for every predetermined time and the pressure within inhalation of air (pressure of the upstream of an inlet valve 2) in a bulb overlap period, the interior EGR gas rate of an instant is computed. It is also possible to control an internal combustion engine based on the internal EGR gas rate obtained by integrating the interior EGR gas rate of an instant. According to this modification, even if it is the case that change of the opening area of the inlet valve 2 in a bulb overlap period, the pressure of the upstream of the inlet valve in a bulb overlap period, and the pressure of the downstream is large, an internal EGR gas rate can be computed correctly and an internal combustion engine can be controlled appropriately.

[0101] Based on the return and interior EGR gas rate KEGRO of the last time in step 403 subsequently, and the pressure PM within inhalation of air, the change rate KEGRSM from last time is computed by explanation of drawing 36 . Drawing 46 is drawing having shown the relation between whenever [effect / of the last internal EGR gas rate], (= the change rate KEGRSM from 1-last time), and the last internal EGR gas rate KEGRO and the pressure PM within inhalation of air. As shown in drawing 46 , whenever [effect / of the last internal EGR gas rate] becomes small as it becomes small as the last internal EGR gas rate KEGRO becomes small, and the pressure PM within inhalation of air becomes high. That is, the change rate KEGRSM from last time becomes large as it becomes large as the last internal EGR gas rate KEGRO becomes small, and the pressure PM within inhalation of air becomes high.

[0102] The internal EGR gas rate KEGR is computed by explanation of drawing 36 based on the return and interior EGR gas rate KEGRO of the internal EGR gas rate stationary value KEGRST and last time in step 404 subsequently (the internal EGR gas rate KEGR computed in step 404 when this routine was performed last time [=]), and the change rate KEGRSM from last time (KEGR<-(KEGRST-KEGRO) xKEGRSM+KEGRO). Subsequently, at step 405, ignition timing SA is computed based on the internal EGR gas rate KEGR, the inhalation air content GN per rotation, and the engine rotational frequency NE. As shown in drawing 47 , the tooth lead angle of the ignition timing SA computed in step 405 is carried out as the internal EGR gas rate KEGR becomes high, and the tooth lead angle of it is carried out as the inhalation air content GN per rotation decreases. Drawing 48 is drawing having shown the relation between ignition timing SA and the engine

rotational frequency NE. The tooth lead angle of the ignition timing SA computed in step 405 is carried out as were shown in drawing 48 , and the engine rotational frequency NE becomes high.
[0103] As mentioned above, in step 401 and step 404 of drawing 36 , an internal EGR gas rate is computed based on the opening area of the inlet valve 2 you are made to change in connection with the amount LT of valve lifts being changed by the amount modification equipment 9 of valve lifts as a good fluctuation valve system, and an internal combustion engine is controlled by this operation gestalt based on the internal EGR gas rate. Therefore, according to this operation gestalt, without taking into consideration modification of the opening area of the inlet valve 2 by the good fluctuation valve system like an internal combustion engine's control unit indicated by JP,9-209895,A, rather than the case where an internal EGR gas rate is computed, an internal EGR gas rate can be computed correctly and an internal combustion engine can be controlled appropriately. That is, even if it is the case where the opening area of an inlet valve 2 is made to change, an internal EGR gas rate can be computed correctly, and an internal combustion engine can be controlled appropriately. An internal combustion engine is controlled by the detail so that ignition timing SA carries out a tooth lead angle, as the internal EGR gas rate which the opening area of an inlet valve 2 increases and which is alike, therefore is computed based on the opening area of an inlet valve becomes high as shown in drawing 37 , and were shown in drawing 47 and an internal EGR gas rate becomes high.
[0104] Furthermore, in step 401 and step 404 of drawing 36 , an internal EGR gas rate is computed based on the working angle VA of the inlet valve 2 you are made to change with the amount modification equipment 9 of valve lifts as a good fluctuation valve system, and an internal combustion engine is controlled by this operation gestalt based on the internal EGR gas rate. Therefore, according to this operation gestalt, without taking into consideration modification of the working angle VA of the inlet valve 2 by the good fluctuation valve system like an internal combustion engine's control unit indicated by JP,9-209895,A, rather than the case where an internal EGR gas rate is computed, an internal EGR gas rate can be computed correctly and an internal combustion engine can be controlled appropriately. That is, even if it is the case where the working angle VA of an inlet valve 2 is made to change, an internal EGR gas rate can be computed correctly, and an internal combustion engine can be controlled appropriately. An internal combustion engine is controlled by the detail so that ignition timing SA carries out a tooth lead angle, as the internal EGR gas rate which the working angle VA of an inlet valve 2 increases and which is alike, therefore is computed based on the working angle of an inlet valve becomes high as shown in drawing 38 , and were shown in drawing 47 and an internal EGR gas rate becomes high.
[0105] Moreover, in step 401 and step 404 of drawing 36 , an internal EGR gas rate is computed based on both the opening area of the inlet valve 2 you are made to change with the amount modification equipment 9 of valve lifts as a good fluctuation valve system, and the working angle VA, and an internal combustion engine is controlled by this operation gestalt based on the internal EGR gas rate. Therefore, according to this operation gestalt, rather than the case where an internal EGR gas rate is computed only based on the opening area of an inlet valve 2, without being based on the working angle VA of an inlet valve 2, and the case where an internal EGR gas rate is computed based on the working angle VA of an inlet valve 2, without being based on the opening area of an inlet valve 2, an internal EGR gas rate can be computed correctly and an internal combustion engine can be controlled appropriately.
[0106] Moreover, in step 401 and step 404 of drawing 36 , an internal EGR gas rate is computed based on the pressure PM and the engine rotational frequency NE the closing motion timing (phase) VT and within inhalation of air of an inlet valve 2, and an internal combustion engine is controlled by this operation gestalt based on the internal EGR gas rate. Therefore, according to this operation gestalt, rather than the case where an internal EGR gas rate is not computed based on the pressure PM and the engine rotational frequency NE the closing motion timing (phase) VT and within inhalation of air of an inlet valve 2, an internal EGR gas rate can be computed correctly and an internal combustion engine can be controlled appropriately.
[0107] Moreover, with this operation gestalt, in step 402 of drawing 36 , an internal EGR gas rate is amended based on atmospheric pressure, an internal EGR gas rate is amended based on the pressure in an exhaust pipe, i.e., back pressure, in the modification of step 402, and an internal EGR gas rate is further amended based on the internal EGR gas rate KEGRO computed by the last routine in step

404. Therefore, according to this operation gestalt, an internal combustion engine is appropriately controllable from the case where an internal EGR gas rate is not amended based on them.
[0108] Although an internal EGR gas rate is computed and the internal combustion engine is controlled by the operation gestalt mentioned above and its modification based on it instead, it is also possible to compute the amount of internal EGR gas and to control an internal combustion engine by the approach mentioned above and the same approach based on it. That is, the inclination of the inclination of the curve in drawing mentioned above becomes the same by the case where the case where an internal EGR gas rate is used, and the amount of internal EGR gas are used.
[0109] In addition, although an internal EGR gas rate or an amount is computed based on the opening area of an inlet valve etc. and the internal combustion engine is controlled by this operation gestalt and its modification based on the internal EGR gas rate or amount, it is also possible to compute an internal EGR gas rate or an amount based on the opening area of an exhaust valve etc., and to control an internal combustion engine by other operation gestalten based on the internal EGR gas rate or amount. That is, this invention is applicable not only to an inlet valve but an exhaust valve.
[0110] Hereafter, the fifth operation gestalt of the control unit of the internal combustion engine of this invention is explained. The configuration of this operation gestalt is the same as the configuration of the first operation gestalt shown in drawing 1 - drawing 7 almost. If the amount of valve lifts of an inlet valve 2, a working angle, and closing motion timing (phase) are made to change by the amount modification equipment 9 of valve lifts, and the closing motion timing shifter 11, extent of the turbulence in a cylinder will change in connection with it. Although extent of the turbulence in a cylinder changes, if ignition is uniformly performed to predetermined timing, it shifts from the optimal ignition timing and an internal combustion engine cannot be controlled appropriately. Therefore, in order to light to the optimal timing and to control an internal combustion engine appropriately, it is necessary to compute correctly extent of the turbulence in a cylinder which changes with modification of the amount of valve lifts of an inlet valve 2, a working angle, and closing motion timing (phase).
[0111] Drawing 49 is the flow chart which showed the ignition timing calculation approach in this operation gestalt. This routine is performed at intervals of predetermined time. If this routine is started as shown in drawing 49 , in step 500, it will be judged first whether it is at the engine starting time. At the time of YES, at the time of engine starting to which fuel increase in quantity is carried out, the turbulence in a cylinder is computed correctly, it judges that it is not necessary to determine ignition timing based on it, and this routine is ended. On the other hand, it progresses to step 501 at the time of NO. At step 501, turbulence CYLTRB in a cylinder is computed based on the pressure PM and the engine rotational frequency NE the amount LT of valve lifts, the working angle VA, the closing motion timing VT, and within inhalation of air of an inlet valve 2.
[0112] Drawing 50 is drawing having shown turbulence CYLTRB in a cylinder, the amount LT of valve lifts, and relation with the closing motion timing (phase) VT. As shown in drawing 50 , turbulence CYLTRB in a cylinder computed in step 501 becomes large as the amount LT of valve lifts becomes small, and it becomes large as the lag of the closing motion timing (a phase, valve-opening stage of an inlet valve 2) VT is carried out. Drawing 51 is drawing having shown turbulence CYLTRB in a cylinder, the working angle VA, and relation with the closing motion timing (phase) VT. As shown in drawing 51 , turbulence CYLTRB in a cylinder computed in step 501 becomes large as the working angle VA becomes small.
[0113] Drawing 52 is drawing having shown relation with the pressure PM turbulence CYLTRB in a cylinder, and within inhalation of air. As shown in drawing 52 , turbulence CYLTRB in a cylinder computed in step 501 becomes small as the pressure PM within inhalation of air becomes high. Drawing 53 is drawing having shown the relation between turbulence CYLTRB in a cylinder, and the engine rotational frequency NE. As shown in drawing 53 , turbulence CYLTRB in a cylinder computed in step 501 becomes large as the engine rotational frequency NE becomes high.
[0114] It returns to explanation of drawing 49 and, subsequently ignition timing SA is computed at step 502 based on turbulence CYLTRB in a cylinder, the inhalation air content GN per rotation, and the engine rotational frequency NE. Drawing 54 is drawing having shown the relation between ignition timing SA, turbulence CYLTRB in a cylinder, and the inhalation air content GN per

rotation. As shown in drawing 54 , the lag of the ignition timing SA computed in step 502 is carried out as turbulence CYLTRB in a cylinder becomes large, and the lag of it is carried out as the inhalation air content GN per rotation increases. Drawing 55 is drawing having shown the relation between ignition timing SA and the engine rotational frequency NE. The tooth lead angle of the ignition timing SA computed in step 502 is carried out as were shown in drawing 55 , and the engine rotational frequency NE becomes high.

[0115] As mentioned above, in step 501 of drawing 49 , turbulence CYLTRB in a cylinder is computed based on the opening area of the inlet valve 2 you are made to change in connection with the amount LT of valve lifts being changed by the amount modification equipment 9 of valve lifts as a good fluctuation valve system, and an internal combustion engine is controlled by this operation gestalt based on the turbulence CYLTRB in a cylinder. Therefore, according to this operation gestalt, without taking into consideration modification of the opening area of the inlet valve 2 by the good fluctuation valve system like an internal combustion engine's control unit indicated by JP,2000-73800,A, rather than the case where turbulence CYLTRB in a cylinder is computed, turbulence CYLTRB in a cylinder can be computed correctly and an internal combustion engine can be controlled appropriately. That is, even if it is the case where the opening area of an inlet valve 2 is made to change, turbulence CYLTRB in a cylinder can be computed correctly, and an internal combustion engine can be controlled appropriately. An internal combustion engine is controlled by the detail so that ignition timing SA carries out a lag, as turbulence CYLTRB in a cylinder to which the opening area of an inlet valve 2 decreases and which is alike, therefore is computed based on the opening area of an inlet valve becomes large as shown in drawing 50 , and were shown in drawing 54 and turbulence CYLTRB in a cylinder becomes large.

[0116] Furthermore, in step 501 of drawing 49 , turbulence CYLTRB in a cylinder is computed based on the pressure PM and the engine rotational frequency NE the working angle VA, the closing motion timing (phase) VT of an inlet valve 2, and within inhalation of air of an inlet valve 2, and an internal combustion engine is controlled by this operation gestalt based on the turbulence CYLTRB in a cylinder. Therefore, according to this operation gestalt, rather than the case where turbulence CYLTRB in a cylinder is not computed based on the pressure PM and the engine rotational frequency NE the working angle VA, the closing motion timing (phase) VT of an inlet valve 2, and within inhalation of air of an inlet valve 2, turbulence CYLTRB in a cylinder can be computed correctly and an internal combustion engine can be controlled appropriately.

[0117] In addition, although the turbulence in a cylinder is computed based on the opening area of an inlet valve etc. and the internal combustion engine is controlled by this operation gestalt and its modification based on the turbulence in the cylinder, it is also possible to compute the turbulence in a cylinder based on the opening area of an exhaust valve etc., and to control an internal combustion engine by other operation gestalten based on the turbulence in the cylinder. That is, this invention is applicable not only to an inlet valve but an exhaust valve.

[0118] Hereafter, the sixth operation gestalt of the control unit of the internal combustion engine of this invention is explained. The configuration of this operation gestalt is the same as the configuration of the first operation gestalt shown in drawing 1 - drawing 7 except for the point mentioned later almost. Moreover, the control routine of this operation gestalt mentioned later is performed combining one control routine of the operation gestalten mentioned above. In the operation gestalt mentioned above, although the cam from which cam-nose height is changing continuously is prepared as shown in drawing 3 , with this operation gestalt, the medium-speed cam M from which the high-speed cam H with comparatively high cam-nose height, the low-speed cam L with comparatively low cam-nose height, and cam-nose height serve as those middle is formed instead.

[0119] Drawing 56 is the flow chart which showed the cam control approach in this operation gestalt. This routine is performed at intervals of predetermined time. If this routine is started as shown in drawing 56 , in step 600, the accelerator opening computed based on the output value of a non-illustrated accelerator opening sensor will be read first. Subsequently, at step 601, the engine rotational frequency computed based on the output value of the engine rotational frequency sensor 17 is read. Subsequently, at step 602, a cam is chosen based on the relation shown in accelerator opening, an engine rotational frequency, and drawing 57 . Drawing 57 is drawing having shown the

relation between accelerator opening, an engine rotational frequency, and the cam that should be chosen. The cam-nose height of the cam chosen as are shown in drawing 57 , and the low-speed cam L is chosen, and the cam-nose height of the cam chosen as accelerator opening becomes large becomes high and an engine rotational frequency becomes high when [when accelerator opening is small] an engine rotational frequency is low becomes high.
[0120] Subsequently, it is judged at step 603 whether it is cam change timing. It progresses to step 604 at the time of YES, and this routine is ended at the time of NO. A change for the selected cam is performed at step 604. Subsequently, at step 605, cam change delay is presumed based on an engine rotational frequency, the cooling water temperature computed based on the output value of the cooling coolant temperature sensor 20, and the relation shown in drawing 58 . Drawing 58 is drawing having shown the relation between cam change delay, an engine rotational frequency, and cooling water temperature. As shown in drawing 58 , cam change delay becomes small as it becomes small as an engine rotational frequency becomes high, and cooling water temperature becomes high.
[0121] It is also possible to presume cam change delay based on the oil pressure of the hydraulic oil which operates a cam instead of presuming cam change delay in the modification of this operation gestalt based on cooling water temperature etc. Drawing 59 is drawing having shown the relation between cam change delay and oil pressure. As shown in drawing 59 , it is presumed that cam change delay becomes small as oil pressure becomes high.
[0122] In other modifications of this operation gestalt, before the change of a cam, based on a service condition or oil pressure, cam change delay is presumed beforehand, and a cam change stage is determined in consideration of the delay. Drawing 60 is drawing having shown the relation between the stage when the directions for switching a cam are issued, and the stage when a cam actually switches etc. As shown in drawing 60 , when cam change delay (= time amount t1-time amount t0) is presumed and it is actually going to switch a cam to time amount t1, the directions for switching a cam will be taken out to time amount t0.
[0123] Drawing 61 is the flow chart which showed the fuel-oil-consumption calculation approach in this operation gestalt. This routine is performed at intervals of predetermined time. If this routine is started as shown in drawing 61 , in step 700, the output value of an air flow meter 19 will be read first. Subsequently, at step 701, the engine rotational frequency computed based on the output value of the engine rotational frequency sensor 17 is read. Subsequently, cam selection estimate is read at step 702. That is, the flag which shows the cam chosen in step 602 of drawing 56 is read. Subsequently, at step 703, the inhalation air content per rotation is computed by the same approach as the operation gestalt mentioned above. Subsequently, at step 704, a response correction factor is computed based on the relation shown in the class of cam, an engine rotational frequency, the inhalation air content per rotation, and drawing 62 . Drawing 62 is drawing having shown the relation between a response correction factor, the class of cam, an engine rotational frequency, and the inhalation air content GN per rotation. Subsequently, at step 705, fuel oil consumption is computed based on the relation shown in the inhalation air content and drawing 63 per rotation. Drawing 63 is drawing having shown the relation between fuel oil consumption and the inhalation air content per rotation.
[0124] Drawing 64 is the flow chart which showed the ignition timing calculation routine in this operation gestalt. This routine is performed at intervals of predetermined time. If this routine is started as shown in drawing 64 , in step 800, the inhalation air content per rotation will be read first. Subsequently, an engine rotational frequency is read at step 801. Subsequently, cam selection estimate is read at step 802. Subsequently, at step 803, ignition timing is computed based on the relation shown in the class of cam, an engine rotational frequency, the inhalation air content per rotation, and drawing 65 . Drawing 65 is drawing having shown the relation between ignition timing, the class of cam, an engine rotational frequency, and the inhalation air content GN per rotation.
[0125] It is also possible to use the induction-exhaust valve driven with electromagnetic force or oil pressure if needed instead of the induction-exhaust valve driven by the cam in the modification of the operation gestalt mentioned above.
[0126]
[Effect of the Invention] According to invention according to claim 1, unlike the case where cylinder internal pressure is detected, not only based on the cylinder internal pressure of a combustion

pressure peak period but the cylinder internal pressure at the times other than a combustion pressure peak period, an internal combustion engine is controllable by the cylinder internal pressure sensor like an internal combustion engine's control unit indicated by JP,9-53503,A. Furthermore, even if it is the case where the opening area of an induction-exhaust valve is made to change, an internal combustion engine is appropriately controllable.

[0127] According to invention according to claim 2, unlike the case where cylinder internal pressure is detected, not only based on the cylinder internal pressure of a combustion pressure peak period but the cylinder internal pressure at the times other than a combustion pressure peak period, an internal combustion engine is controllable by the cylinder internal pressure sensor like an internal combustion engine's control unit indicated by JP,9-53503,A. Furthermore, even if it is the case where the working angle of an induction-exhaust valve is made to change, an internal combustion engine is appropriately controllable.

[0128] According to invention according to claim 3, rather than the case where cylinder internal pressure is computed only based on the opening area of an induction-exhaust valve, without being based on the working angle of an induction-exhaust valve, and the case where cylinder internal pressure is computed based on the operation corner chisel of an induction-exhaust valve, without being based on the opening area of an induction-exhaust valve, cylinder internal pressure can be computed correctly and an internal combustion engine can be controlled appropriately.

[0129] According to invention according to claim 4, rather than the case where cylinder internal pressure is not computed based on the phase of an inlet valve, the pressure within inhalation of air, and an engine rotational frequency, cylinder internal pressure can be computed correctly and an internal combustion engine can be controlled appropriately.

[0130] According to invention according to claim 5, an internal combustion engine is appropriately controllable from the case where an internal combustion engine is controlled based on cylinder wall ** like an internal combustion engine's control unit indicated by JP,4-81574,A. Furthermore, even if it is the case where the opening area of an induction-exhaust valve is made to change, an internal combustion engine is appropriately controllable.

[0131] According to invention according to claim 6, an internal combustion engine is appropriately controllable from the case where an internal combustion engine is controlled based on cylinder wall ** like an internal combustion engine's control unit indicated by JP,4-81574,A. Furthermore, even if it is the case where the working angle of an induction-exhaust valve is made to change, an internal combustion engine is appropriately controllable.

[0132] According to invention according to claim 7, rather than the case where the gas temperature in a cylinder is computed only based on the opening area of an induction-exhaust valve, without being based on the working angle of an induction-exhaust valve, and the case where the gas temperature in a cylinder is computed based on the operation corner chisel of an induction-exhaust valve, without being based on the opening area of an induction-exhaust valve, the gas temperature in a cylinder can be computed correctly and an internal combustion engine can be controlled appropriately.

[0133] According to invention according to claim 8, rather than the case where the gas temperature in a cylinder is not computed based on the phase of an inlet valve, the pressure within inhalation of air, and an engine rotational frequency, the gas temperature in a cylinder can be computed correctly and an internal combustion engine can be controlled appropriately.

[0134] According to invention according to claim 9, an internal combustion engine is appropriately controllable from the case where the gas temperature in a cylinder is not amended based on at least one of them.

[0135] According to invention according to claim 10, without taking into consideration modification of the opening area of the induction-exhaust valve by the good fluctuation valve system like an internal combustion engine's control unit indicated by JP,9-209895,A, rather than the case where an internal EGR gas rate or an amount is computed, an internal EGR gas rate or an amount can be computed correctly, and an internal combustion engine can be controlled appropriately. That is, even if it is the case where the opening area of an induction-exhaust valve is made to change, the amount of internal EGR gas can be computed correctly, and an internal combustion engine can be controlled appropriately.

[0136] According to invention according to claim 11, without taking into consideration modification of the working angle of the induction-exhaust valve by the good fluctuation valve system like an internal combustion engine's control unit indicated by JP,9-209895,A, rather than the case where an internal EGR gas rate or an amount is computed, an internal EGR gas rate or an amount can be computed correctly, and an internal combustion engine can be controlled appropriately. That is, even if it is the case where the working angle of an induction-exhaust valve is made to change, the amount of internal EGR gas can be computed correctly, and an internal combustion engine can be controlled appropriately.
[0137] According to invention according to claim 12, rather than the case where an internal EGR gas rate or an amount is computed only based on the opening area of an induction-exhaust valve, without being based on the working angle of an induction-exhaust valve, and the case where an internal EGR gas rate or an amount is computed based on the operation corner chisel of an induction-exhaust valve, without being based on the opening area of an induction-exhaust valve, an internal EGR gas rate or an amount can be computed correctly, and an internal combustion engine can be controlled appropriately.
[0138] According to invention according to claim 13, rather than the case where an internal EGR gas rate or an amount is not computed based on the phase of an inlet valve, the pressure within inhalation of air, and an engine rotational frequency, an internal EGR gas rate or an amount can be computed correctly, and an internal combustion engine can be controlled appropriately.
[0139] According to invention according to claim 14, an internal combustion engine is appropriately controllable from the case where an internal EGR gas rate or an amount is not amended based on at least one of them.
[0140] According to invention according to claim 15, only based on one [at least] opening area of the inlet valve and exhaust valve you are made to change by the good fluctuation valve system, an internal EGR gas rate or an amount is computed. Rather than the case where an internal EGR gas rate or an amount is not computed based on the pressure of the upstream of the inlet valve in a bulb overlap period, and the pressure of the downstream, an internal EGR gas rate or an amount can be computed correctly, and an internal combustion engine can be controlled appropriately.
[0141] According to invention according to claim 16, even if it is the case that change of the opening area of an induction-exhaust valve, the pressure of the upstream of the inlet valve in a bulb overlap period, and the pressure of the downstream is large, an internal EGR gas rate or an amount can be computed correctly, and an internal combustion engine can be controlled appropriately.
[0142] It is presumed that according to invention according to claim 17 extent of the turbulence in a cylinder decreases as the opening area of an inlet valve decreases. It differs from an internal combustion engine's control unit indicated by JP,2000-73800,A by which an internal combustion engine is controlled based on extent of the turbulence in the presumed cylinder. Even if it is the case where the opening area of an inlet valve is made to change by the good fluctuation valve system, extent of the turbulence in a cylinder can be presumed correctly and an internal combustion engine can be controlled appropriately.
[0143] According to invention according to claim 18, rather than the case where extent of the turbulence in a cylinder is not presumed based on the phase of an inlet valve, the pressure within inhalation of air, and an engine rotational frequency, extent of the turbulence in a cylinder can be presumed correctly and an internal combustion engine can be controlled appropriately.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the outline block diagram of the first operation gestalt of the control unit of the internal combustion engine of this invention.
[Drawing 2] They are detail drawing, such as an inhalation-of-air system of an internal combustion engine's control unit shown in drawing 1 .
[Drawing 3] It is the detail drawing of the cam for inlet valves shown in drawing 1 , and a cam shaft.
[Drawing 4] They are detail drawing, such as the amount modification equipment of valve lifts shown in drawing 1 .
[Drawing 5] It is drawing having shown signs that the amount of valve lifts of an inlet valve changed in connection with the amount modification equipment of valve lifts operating.
[Drawing 6] They are detail drawing, such as a closing motion timing shifter shown in drawing 1 .
[Drawing 7] It is drawing having shown signs that the closing motion timing of an inlet valve shifted in connection with a closing motion timing shifter operating.
[Drawing 8] It is the flow chart which showed the ignition timing calculation approach in the first operation gestalt.
[Drawing 9] It is drawing having shown the relation between the cylinder internal pressure standard condition PCYLb, the amount LT of valve lifts, and the pressure PM within inhalation of air at the time of a compression top dead center.
[Drawing 10] It is drawing having shown the relation between the cylinder internal pressure reference condition PCYLb, the working angle VA, and the pressure PM within inhalation of air at the time of a compression top dead center.
[Drawing 11] It is drawing having shown the relation between the cylinder internal pressure reference condition PCYLb, the working angle VA, and the pressure PM within inhalation of air at the time of a compression top dead center.
[Drawing 12] It is drawing having shown relation with the pressure PM the cylinder internal pressure reference condition PCYLb, the closing motion timing (phase) VT, and within inhalation of air at the time of a compression top dead center.
[Drawing 13] It is drawing having shown relation with the pressure PM the cylinder internal pressure reference condition PCYLb, the closing motion timing (phase) VT, and within inhalation of air at the time of a compression top dead center.
[Drawing 14] It is drawing having shown the relation between the cylinder internal pressure reference condition PCYLb and the engine rotational frequency NE at the time of a compression top dead center.
[Drawing 15] It is drawing having shown the relation between the cylinder internal pressure PCYL and the inhalation air content GN inhaled in a gas column per rotation at the time of ignition timing SA and a compression top dead center.
[Drawing 16] It is drawing having shown the relation between ignition timing SA and the engine rotational frequency NE.
[Drawing 17] It is the flow chart which showed the fuel-oil-consumption calculation approach in the second operation gestalt.
[Drawing 18] It is drawing having shown the relation between the cylinder internal pressure standard condition PCYLINb, the amount LT of valve lifts, and the pressure PM within inhalation of air at the

time of an inhalation-of-air bottom dead point.
[Drawing 19] It is drawing having shown the relation between the cylinder internal pressure reference condition PCYLINb, the working angle VA, and the pressure PM within inhalation of air at the time of an inhalation-of-air bottom dead point.
[Drawing 20] It is drawing having shown relation with the pressure PM the cylinder internal pressure reference condition PCYLINb, the closing motion timing (phase) VT, and within inhalation of air at the time of an inhalation-of-air bottom dead point.
[Drawing 21] It is drawing having shown the relation between the cylinder internal pressure reference condition PCYLINb and the engine rotational frequency NE at the time of an inhalation-of-air bottom dead point.
[Drawing 22] It is drawing having shown the cylinder internal pressure PCYLIN and relation with the closing motion timing (a phase, bulb overlap) VT at the time of fuel oil consumption QINJ and an inhalation-of-air bottom dead point.
[Drawing 23] It is the flow chart which showed the ignition timing calculation approach in the third operation gestalt.
[Drawing 24] It is drawing having shown the gas-temperature standard condition TCYLb in a cylinder, the amount LT of valve lifts, and relation with the closing motion timing (phase) VT at the time of a compression top dead center.
[Drawing 25] It is drawing having shown the gas-temperature standard condition TCYLb in a cylinder, the amount LT of valve lifts, and relation with the closing motion timing (phase) VT at the time of a compression top dead center.
[Drawing 26] It is drawing having shown the relation between the gas-temperature standard condition TCYLb in a cylinder, the amount LT of valve lifts, and the working angle VA at the time of a compression top dead center.
[Drawing 27] It is drawing having shown the relation between the gas-temperature standard condition TCYLb in a cylinder, the amount LT of valve lifts, and the working angle VA at the time of a compression top dead center.
[Drawing 28] It is drawing having shown relation with the pressure PM the gas-temperature reference condition TCYLb in a cylinder, and within inhalation of air at the time of a compression top dead center.
[Drawing 29] It is drawing having shown the relation between the gas-temperature reference condition TCYLb in a cylinder, and the engine rotational frequency NE at the time of a compression top dead center.
[Drawing 30] It is drawing having shown difference with the gas-temperature reference condition TCYLb in a cylinder, and relation with the engine rotational frequency NE at the time of the heat-receiving correction value KTWALL, cylinder wall ** Twall, and a compression top dead center.
[Drawing 31] It is drawing having shown the relation between inhalation sky atmospheric temperature change correction value KTIN, the engine cooling water temperature Tw, and the inhalation air content Ga.
[Drawing 32] It is drawing having shown the relation between the internal EGR gas temperature-change correction value KTEGR and an internal EGR gas rate.
[Drawing 33] It is drawing having shown the relation between the internal EGR gas temperature-change correction value KTEGR, the last ignition timing, and the amount of combustion products per last rotation.
[Drawing 34] It is drawing having shown the relation between the internal EGR gas temperature-change correction value KTEGR and the last air-fuel ratio.
[Drawing 35] It is drawing having shown the relation between gas-temperature TCYL in a cylinder, and the inhalation air content GN per rotation at the time of ignition timing SA and a compression top dead center.
[Drawing 36] It is the flow chart which showed the ignition timing calculation approach in the fourth operation gestalt.
[Drawing 37] It is drawing having shown the internal EGR gas rate standard-condition stationary value KEGRb, the amount LT of valve lifts, and relation with the closing motion timing (phase) VT.
[Drawing 38] It is drawing having shown the internal EGR gas rate reference condition stationary

value KEGRb, the working angle VA, and relation with the closing motion timing (phase) VT.
[Drawing 39] It is drawing having shown the relation between the internal EGR gas rate reference condition stationary value KEGRb and the pressure PM within inhalation of air.
[Drawing 40] It is drawing having shown the relation between the internal EGR gas rate reference condition stationary value KEGRb and the engine rotational frequency NE.
[Drawing 41] It is drawing having shown the relation between the atmospheric pressure correction factor KPA and atmospheric pressure.
[Drawing 42] It is drawing having shown the relation between back pressure, the engine rotational frequency NE, and the inhalation air content GN per rotation.
[Drawing 43] It is drawing having shown the relation between the back pressure correction factor for amending an internal EGR gas rate, and back pressure.
[Drawing 44] It is drawing in which having blown over and having shown the relation between capacity, an average opening area (average value of the opening area of the inlet valve in a bulb overlap period) of an inlet valve 2, and average inlet-valve 2 order differential pressure (average value of the difference of the cylinder internal pressure in a bulb overlap period, and the pressure within inhalation of air).
[Drawing 45] It is drawing in which having blown over with the internal EGR gas rate stationary value KEGRST, and having shown relation with capacity.
[Drawing 46] It is drawing having shown the relation between whenever [effect / of the last internal EGR gas rate], (the change rate KEGRSM from =1-last time), and the last internal EGR gas rate KEGRO and the pressure PM within inhalation of air.
[Drawing 47] It is drawing having shown the relation between ignition timing SA, and the internal EGR gas rate KEGR and the inhalation air content GN per rotation.
[Drawing 48] It is drawing having shown the relation between ignition timing SA and the engine rotational frequency NE.
[Drawing 49] It is the flow chart which showed the ignition timing calculation approach in the fifth operation gestalt.
[Drawing 50] It is drawing having shown turbulence CYLTRB in a cylinder, the amount LT of valve lifts, and relation with the closing motion timing (phase) VT.
[Drawing 51] It is drawing having shown turbulence CYLTRB in a cylinder, the working angle VA, and relation with the closing motion timing (phase) VT.
[Drawing 52] It is drawing having shown relation with the pressure PM turbulence CYLTRB in a cylinder, and within inhalation of air.
[Drawing 53] It is drawing having shown the relation between turbulence CYLTRB in a cylinder, and the engine rotational frequency NE.
[Drawing 54] It is drawing having shown the relation between ignition timing SA, turbulence CYLTRB in a cylinder, and the inhalation air content GN per rotation.
[Drawing 55] It is drawing having shown the relation between ignition timing SA and the engine rotational frequency NE.
[Drawing 56] It is the flow chart which showed the cam control approach in the sixth operation gestalt.
[Drawing 57] It is drawing having shown the relation between accelerator opening, an engine rotational frequency, and the cam that should be chosen.
[Drawing 58] It is drawing having shown the relation between cam change delay, an engine rotational frequency, and cooling water temperature.
[Drawing 59] It is drawing having shown the relation between cam change delay and oil pressure.
[Drawing 60] It is drawing having shown the relation between the stage when the directions for switching a cam are issued, and the stage when a cam actually switches etc.
[Drawing 61] It is the flow chart which showed the fuel-oil-consumption calculation approach in the sixth operation gestalt.
[Drawing 62] It is drawing having shown the relation between a response correction factor, the class of cam, an engine rotational frequency, and the inhalation air content GN per rotation.
[Drawing 63] It is drawing having shown the relation between fuel oil consumption and the inhalation air content per rotation.

[Drawing 64] It is the flow chart which showed the ignition timing calculation routine in the sixth operation gestalt.
[Drawing 65] It is drawing having shown the relation between ignition timing, the class of cam, an engine rotational frequency, and the inhalation air content GN per rotation.
[Description of Notations]
1 -- Internal combustion engine
2 -- Inlet valve
3 -- Exhaust valve
4 5 -- Cam
6 7 -- Cam shaft
8 -- Combustion chamber in a gas column
9 -- The amount modification equipment of valve lifts
11 -- Closing motion timing shifter
18 -- Pressure-of-induction-pipe sensor
19 -- Air flow meter

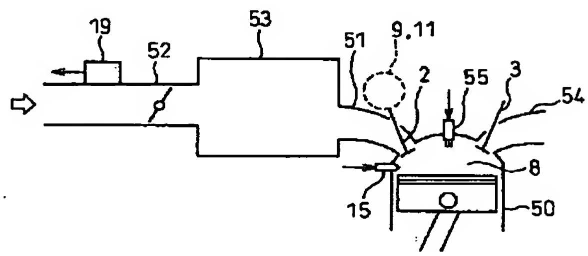
[Translation done.]

* NOTICES *

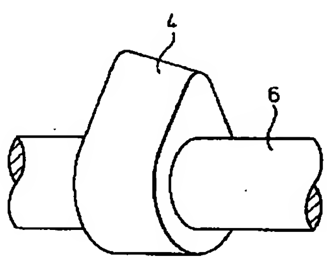
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

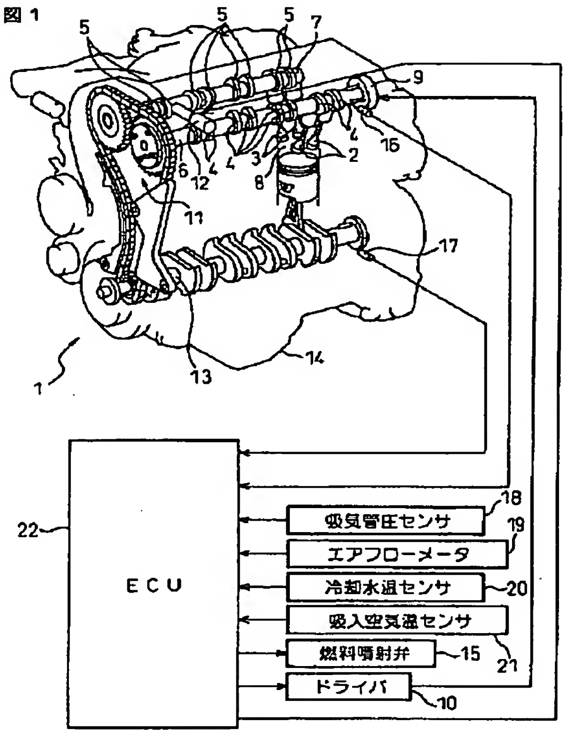
[Drawing 2]
図 2



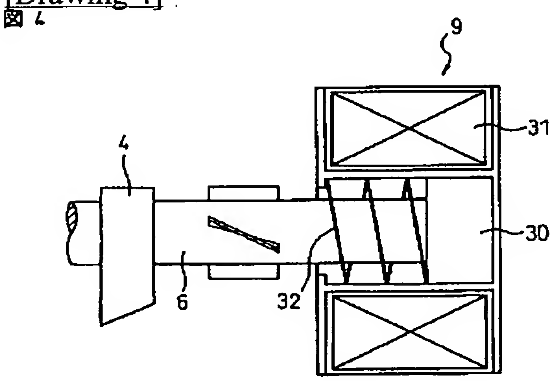
[Drawing 3]
図 3



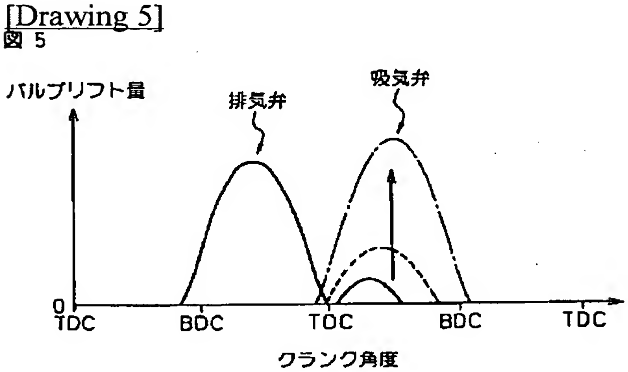
[Drawing 1]



[Drawing 4]

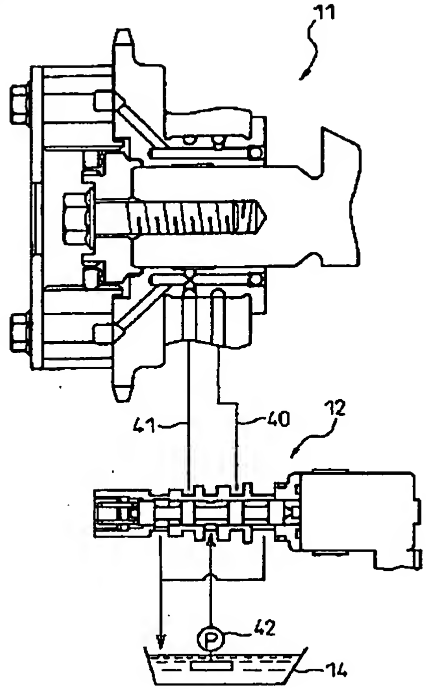


[Drawing 5]



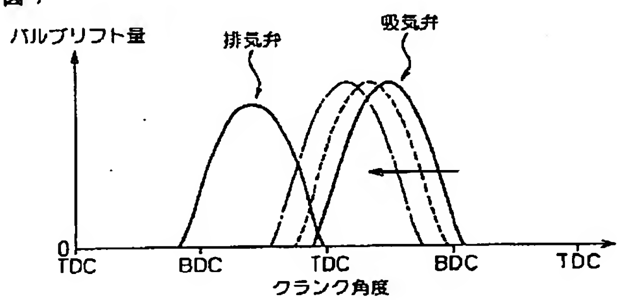
[Drawing 6]

図 6



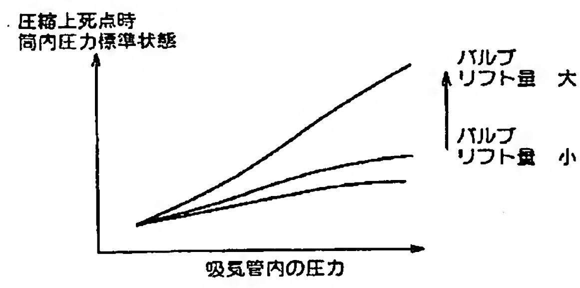
[Drawing 7]

図 7



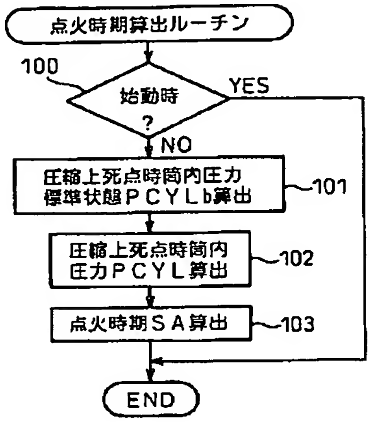
[Drawing 9]

図 9



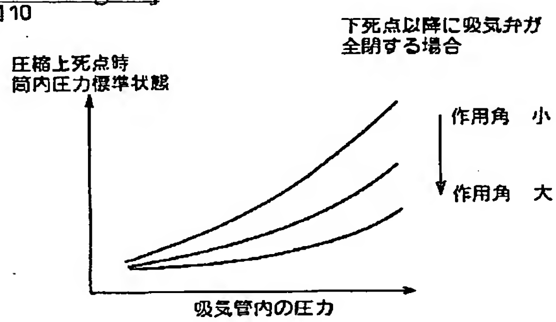
[Drawing 8]

図 8



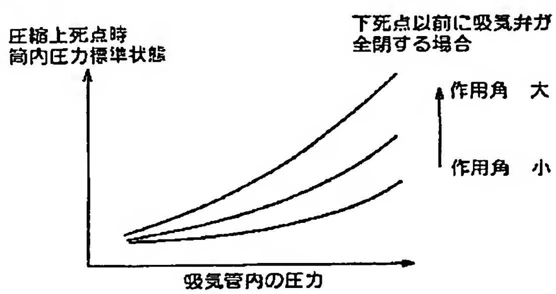
[Drawing 10]

図 10



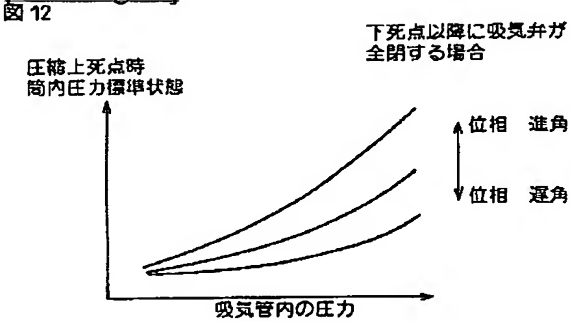
[Drawing 11]

図 11



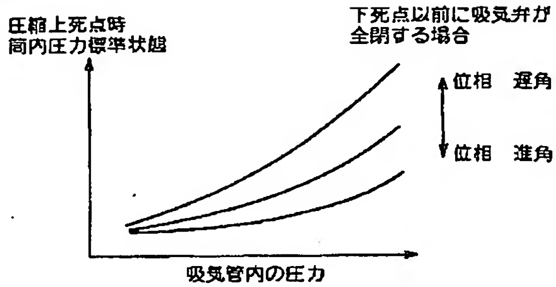
[Drawing 12]

図 12

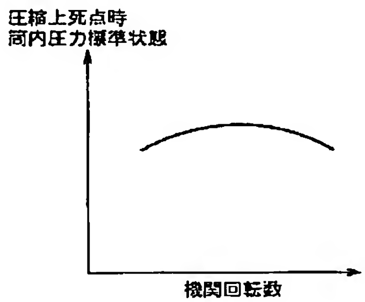


[Drawing 13]

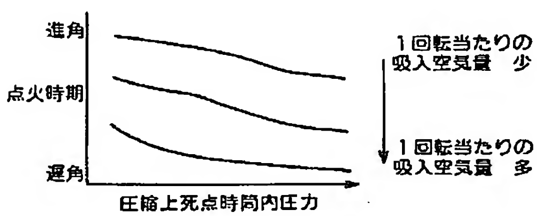
図 13



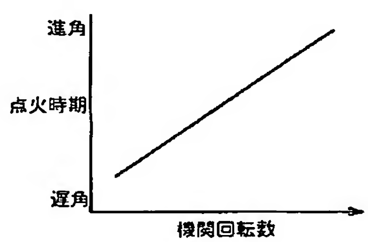
[Drawing 14]
図 14



[Drawing 15]
図 15

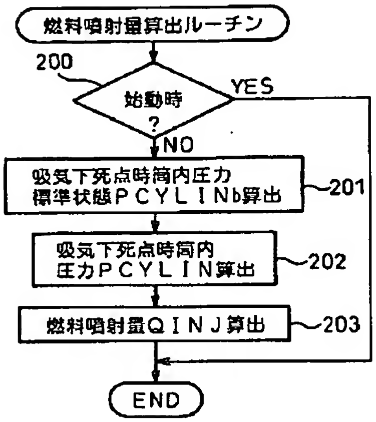


[Drawing 16]
図 16



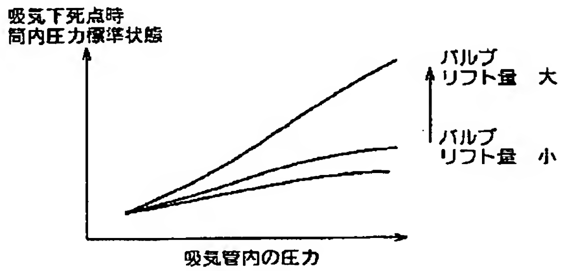
[Drawing 17]

図 17



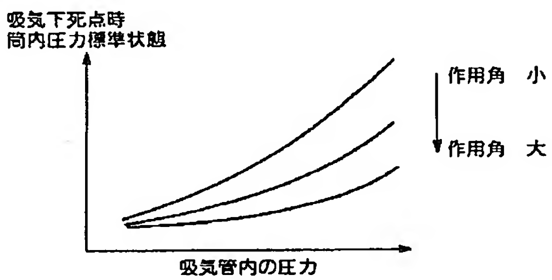
[Drawing 18]

図 18



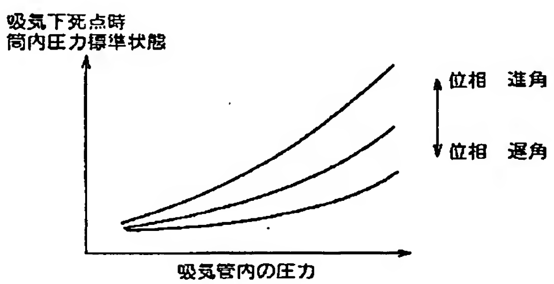
[Drawing 19]

図 19



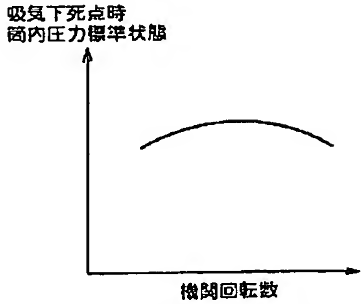
[Drawing 20]

図 20

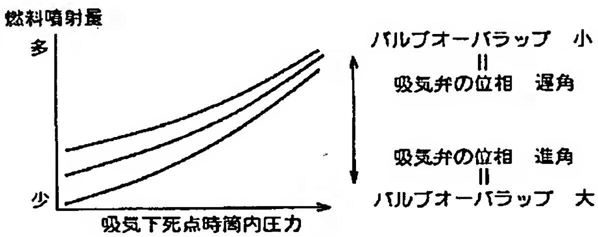


[Drawing 21]

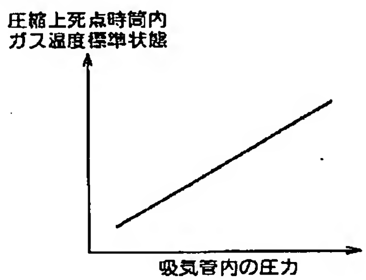
図 21



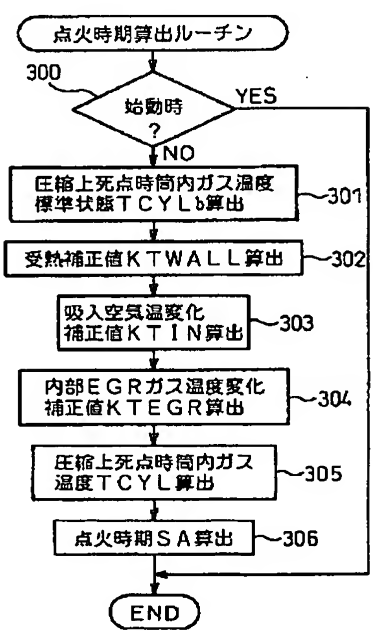
[Drawing 22]
図 22



[Drawing 28]
図 28

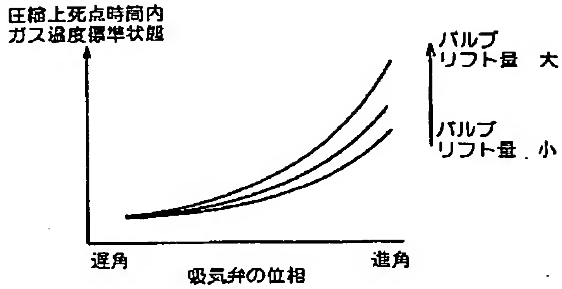


[Drawing 23]
図 23



[Drawing 24]

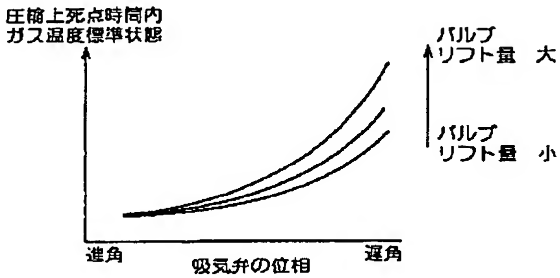
図 24



吸気下死点以降に
吸気弁が全閉する場合

[Drawing 25]

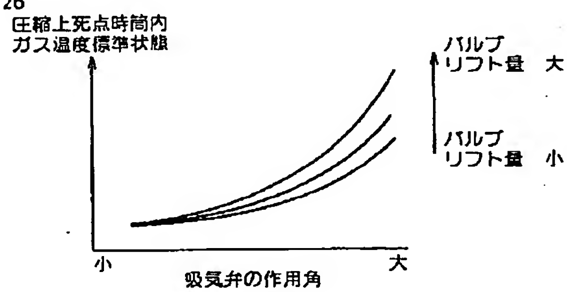
図 25



吸気下死点以前に
吸気弁が全閉する場合

[Drawing 26]

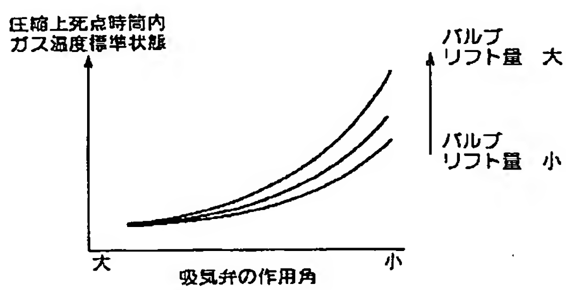
図 26



吸気下死点以降に
吸気弁が全閉する場合

[Drawing 27]

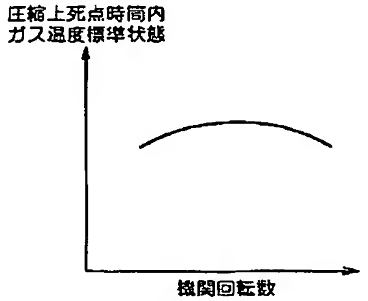
図 27



吸気下死点以前に
吸気弁が全閉する場合

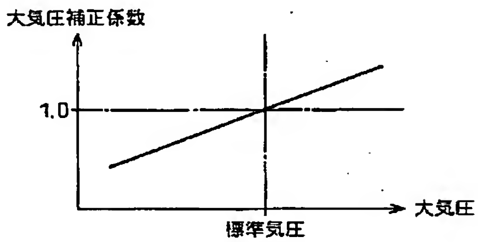
[Drawing 29]

図 29



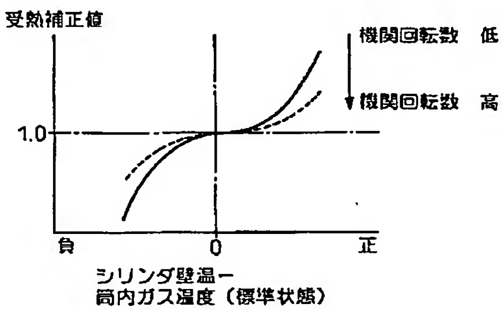
[Drawing 41]

図 41



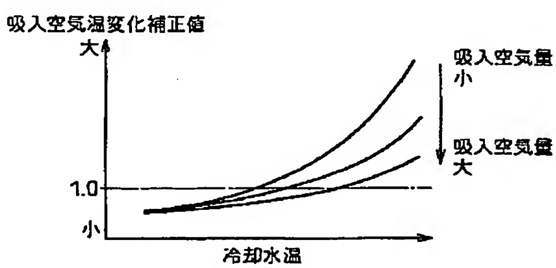
[Drawing 30]

図 30



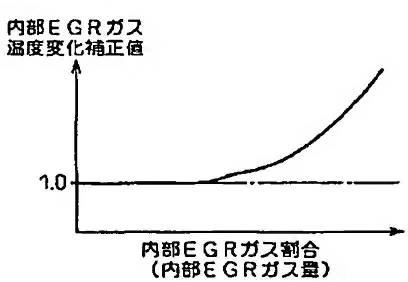
[Drawing 31]

図 31

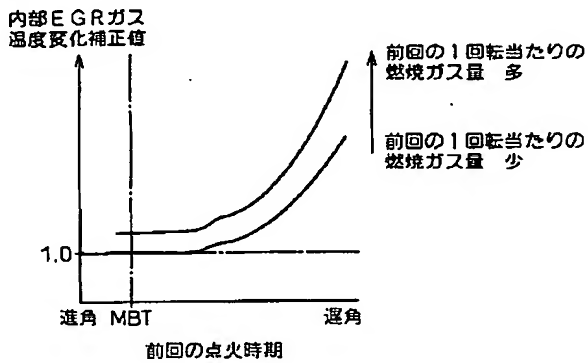


[Drawing 32]

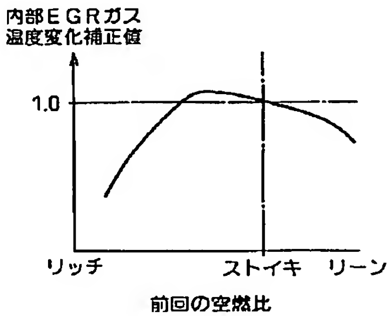
図 32



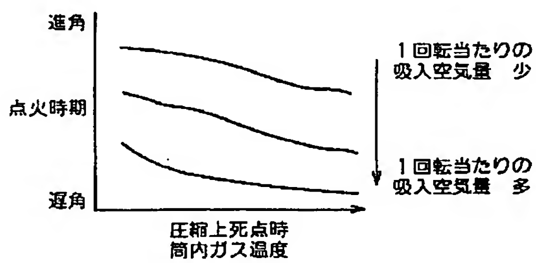
[Drawing 33]
図 33



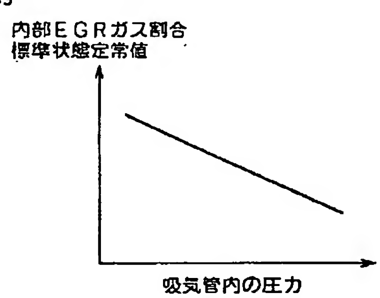
[Drawing 34]
図 34



[Drawing 35]
図 35

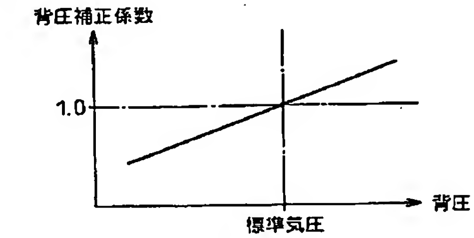


[Drawing 39]
図 39



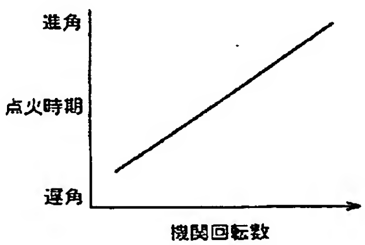
[Drawing 43]

図 43



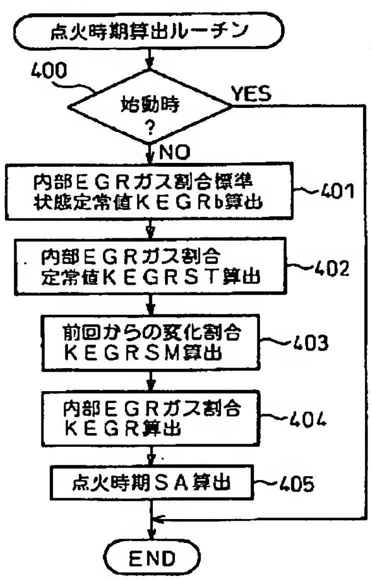
[Drawing 48]

図 48



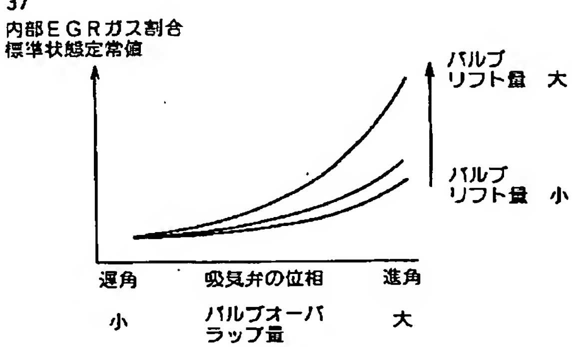
[Drawing 36]

図 36



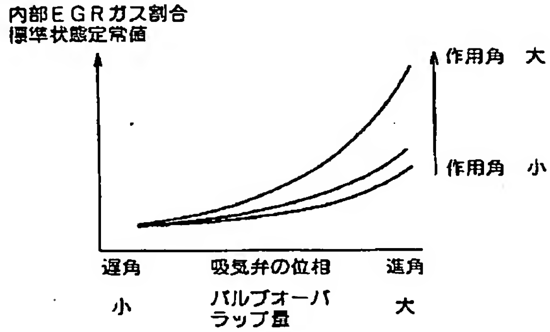
[Drawing 37]

図 37



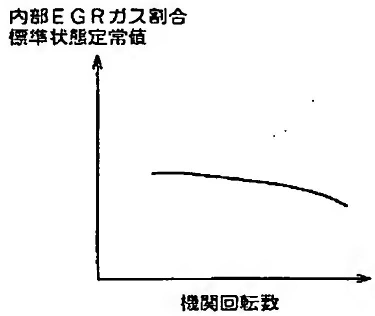
[Drawing 38]

図 38



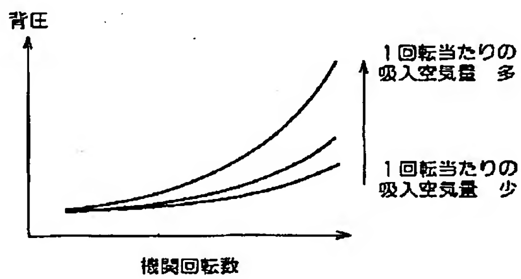
[Drawing 40]

図 40



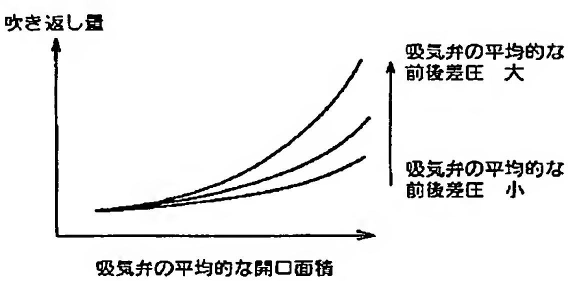
[Drawing 42]

図 42



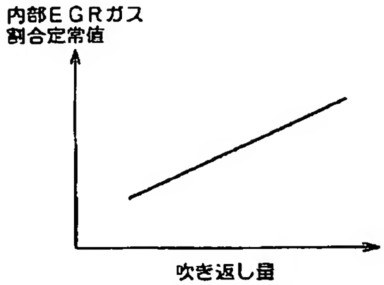
[Drawing 44]

図 44



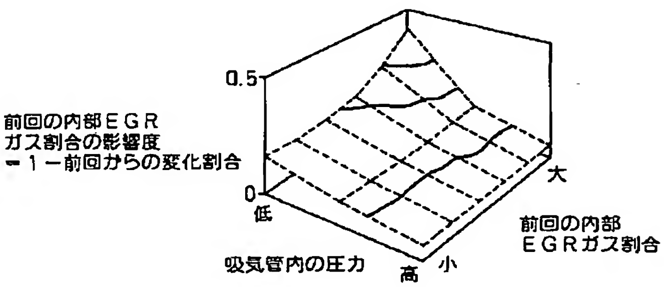
[Drawing 45]

図 45

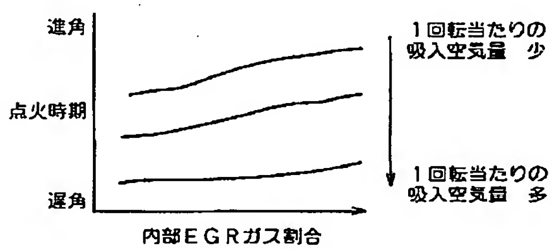


[Drawing 46]

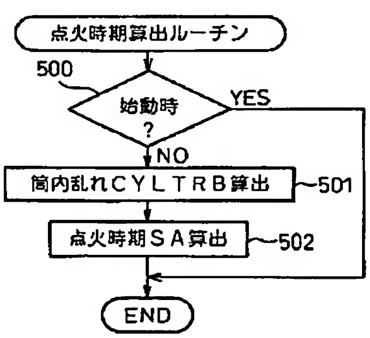
図 46



[Drawing 47]
図 47

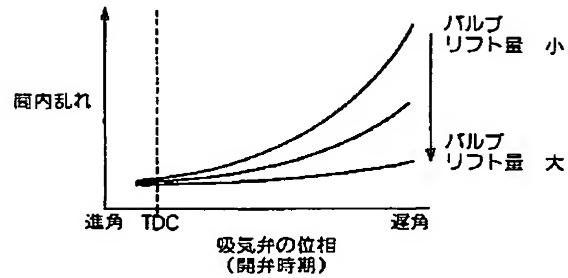


[Drawing 49]
図 49

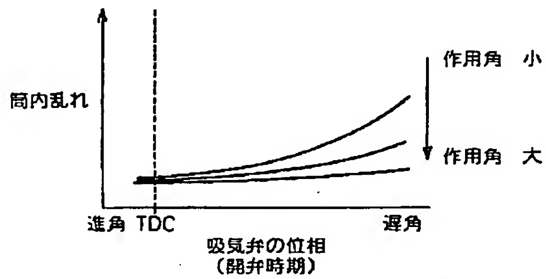


[Drawing 50]

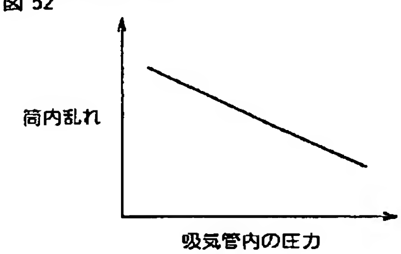
図 50



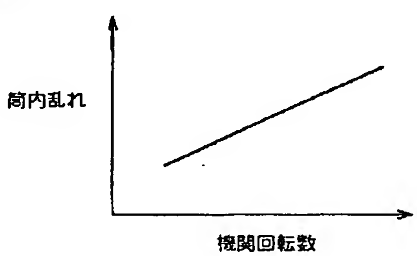
[Drawing 51]
図 51



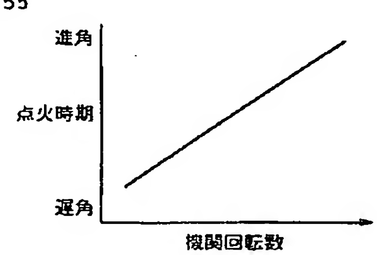
[Drawing 52]
図 52



[Drawing 53]
図 53

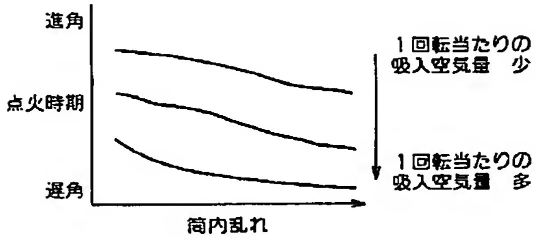


[Drawing 55]
図 55

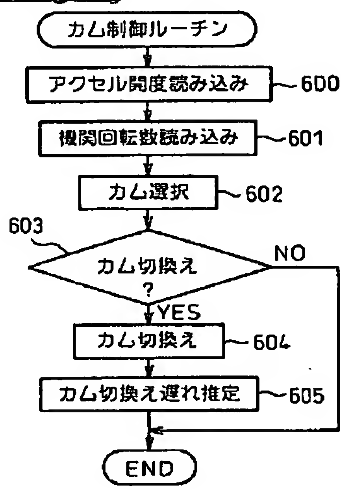


[Drawing 54]

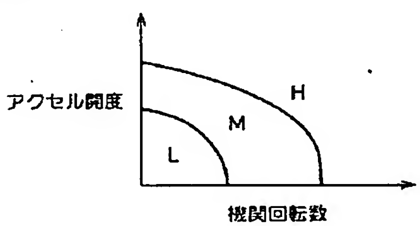
図 54



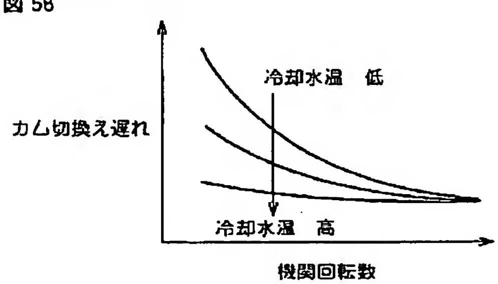
[Drawing 56]
図 56



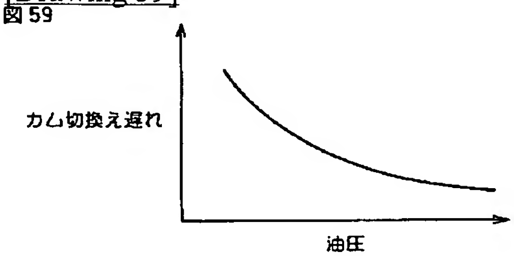
[Drawing 57]
図 57



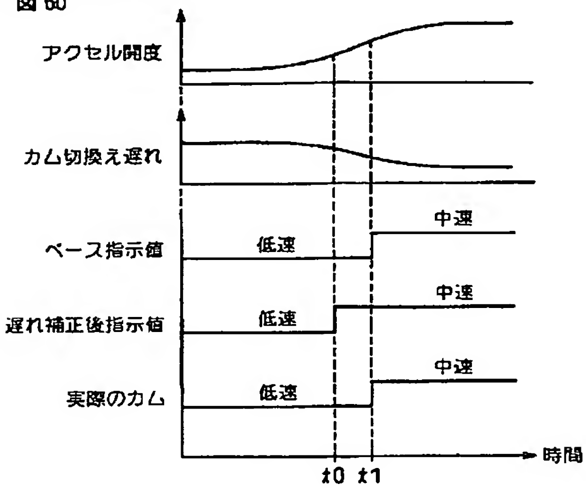
[Drawing 58]
図 58



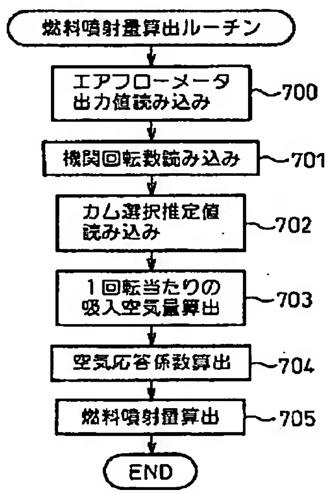
[Drawing 59]
図 59



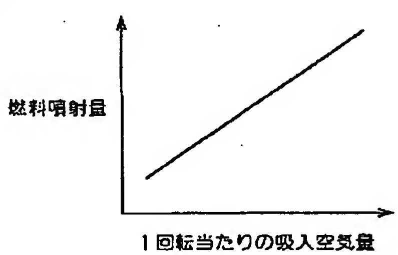
[Drawing 60]
図 60



[Drawing 61]
図 61

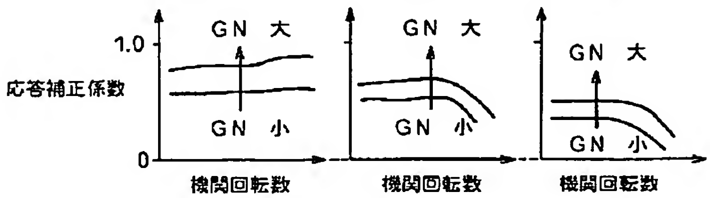


[Drawing 63]
図 63



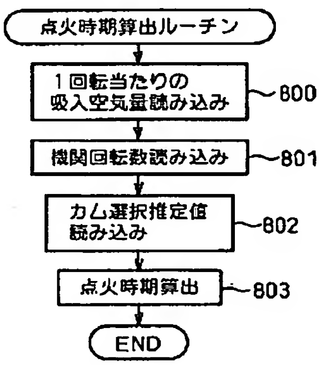
[Drawing 62]

図 62



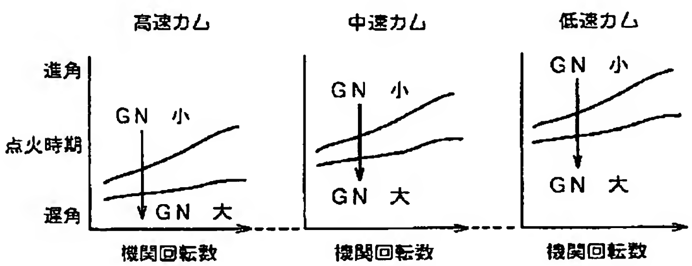
[Drawing 64]

図 64



[Drawing 65]

図 65



[Translation done.]

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(11)特許出願公開番号
特開2002－180894
（Ｐ2002－180894Ａ）
(43)公開日　平成14年6月26日(2002.6.26)

(51)Int.Cl.[7]	識別記号	ＦＩ			テーマコード（参考）
F02D 45/00	368	F02D 45/00	368	S	3G084
13/02		13/02		J	3G092
				K	
43/00	301	43/00	301	B	
			301	H	

審査請求　有　請求項の数18　ＯＬ　（全30頁）　最終頁に続く

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(22)出願日　平成12年12月12日(2000.12.12)

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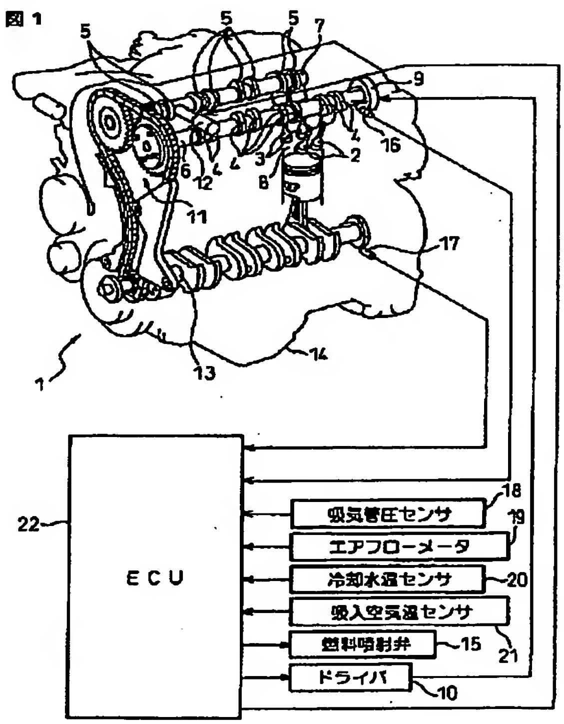
弁理士　石田　敬　（外３名）

最終頁に続く

(54)【発明の名称】内燃機関の制御装置

(57)【要約】
【課題】　燃焼圧ピーク時の筒内圧のみならず燃焼圧ピーク時以外の時点の筒内圧にも基づいて内燃機関を制御し、吸排気弁の開口面積又は作用角が変更せしめられる場合であっても内燃機関を適切に制御する。
【解決手段】　吸気弁２及び排気弁３の少なくとも一方の開口面積又は作用角を変更するための可変動弁機構としてのバルブリフト量変更装置９を具備し、その可変動弁機構によって変更せしめられる吸気弁２及び排気弁３の少なくとも一方の開口面積又は作用角に基づいて筒内圧を算出し、その筒内圧に基づいて内燃機関を制御する。

図１



【特許請求の範囲】

【請求項１】　筒内圧に基づいて内燃機関を制御するようにした内燃機関の制御装置において、吸気弁及び排気弁の少なくとも一方の開口面積を変更するための可変動弁機構を具備し、その可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の開口面積に基づいて筒内圧を算出し、その筒内圧に基づいて内燃機関を制御することを特徴とする内燃機関の制御装置。

【請求項２】　筒内圧に基づいて内燃機関を制御するようにした内燃機関の制御装置において、吸気弁及び排気弁の少なくとも一方の作用角を変更するための可変動弁機構を具備し、その可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の作用角に基づいて筒内圧を算出し、その筒内圧に基づいて内燃機関を制御することを特徴とする内燃機関の制御装置。

【請求項３】　吸気弁及び排気弁の少なくとも一方の開口面積及び作用角を変更するための可変動弁機構を具備し、その可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の開口面積及び作用角に基づいて筒内圧を算出し、その筒内圧に基づいて内燃機関を制御することを特徴とする請求項１又は２に記載の内燃機関の制御装置。

【請求項４】　吸気弁の位相、吸気管内の圧力、及び機関回転数に基づいて筒内圧を算出し、その筒内圧に基づいて内燃機関を制御することを特徴とする請求項３に記載の内燃機関の制御装置。

【請求項５】　気筒内のある部分の温度に基づいて内燃機関を制御するようにした内燃機関の制御装置において、吸気弁及び排気弁の少なくとも一方の開口面積を変更するための可変動弁機構を具備し、その可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の開口面積に基づいて筒内ガス温度を算出し、その筒内ガス温度に基づいて内燃機関を制御することを特徴とする内燃機関の制御装置。

【請求項６】　気筒内のある部分の温度に基づいて内燃機関を制御するようにした内燃機関の制御装置において、吸気弁及び排気弁の少なくとも一方の作用角を変更するための可変動弁機構を具備し、その可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の作用角に基づいて筒内ガス温度を算出し、その筒内ガス温度に基づいて内燃機関を制御することを特徴とする内燃機関の制御装置。

【請求項７】　吸気弁及び排気弁の少なくとも一方の開口面積及び作用角を変更するための可変動弁機構を具備し、その可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の開口面積及び作用角に基づいて筒内ガス温度を算出し、その筒内ガス温度に基づいて内燃機関を制御することを特徴とする請求項５又は６に記載の内燃機関の制御装置。

【請求項８】　吸気弁の位相、吸気管内の圧力、及び機関回転数に基づいて筒内ガス温度を算出し、その筒内ガス温度に基づいて内燃機関を制御することを特徴とする請求項７に記載の内燃機関の制御装置。

【請求項９】　シリンダ壁温、機関回転数、吸入空気量、内部ＥＧＲガス量、内部ＥＧＲガス温度のうちの少なくとも一つに基づいて筒内ガス温度を補正することを特徴とする請求項５～８のいずれか一項に記載の内燃機関の制御装置。

【請求項１０】　吸気弁及び排気弁の少なくとも一方のための可変動弁機構を具備し、内部ＥＧＲガス割合又は量に基づいて内燃機関を制御するようにした内燃機関の制御装置において、可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の開口面積に基づいて内部ＥＧＲガス割合又は量を算出し、その内部ＥＧＲガス割合又は量に基づいて内燃機関を制御することを特徴とする内燃機関の制御装置。

【請求項１１】　吸気弁及び排気弁の少なくとも一方のための可変動弁機構を具備し、内部ＥＧＲガス割合又は量に基づいて内燃機関を制御するようにした内燃機関の制御装置において、可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の作用角に基づいて内部ＥＧＲガス割合又は量を算出し、その内部ＥＧＲガス割合又は量に基づいて内燃機関を制御することを特徴とする内燃機関の制御装置。

【請求項１２】　可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の開口面積及び作用角に基づいて内部ＥＧＲガス割合又は量を算出し、その内部ＥＧＲガス割合又は量に基づいて内燃機関を制御することを特徴とする請求項１０又は１１に記載の内燃機関の制御装置。

【請求項１３】　吸気弁の位相、吸気管内の圧力、及び機関回転数に基づいて内部ＥＧＲガス割合又は量を算出し、その内部ＥＧＲガス割合又は量に基づいて内燃機関を制御することを特徴とする請求項１２に記載の内燃機関の制御装置。

【請求項１４】　大気圧、排気管内の圧力、及び前回算出した内部ＥＧＲガス割合又は量のうちの少なくとも一つに基づいて内部ＥＧＲガス割合又は量を補正することを特徴とする請求項１０～１３のいずれか一項に記載の内燃機関の制御装置。

【請求項１５】　可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の開口面積と、バルブオーバラップ期間中における吸気弁の上流側の圧力及び下流側の圧力とに基づいて内部ＥＧＲガス割合又は量を算出し、その内部ＥＧＲガス割合又は量に基づいて内燃機関を制御することを特徴とする請求項１０に記載の内燃機関の制御装置。

【請求項１６】　可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の所定時間毎の開口面積と、バルブオーバラップ期間中における所定時間

毎の吸気弁の上流側の圧力及び下流側の圧力とに基づいて瞬時内部ＥＧＲガス割合又は量を算出し、その瞬時内部ＥＧＲガス割合又は量を積算することにより得られた内部ＥＧＲガス割合又は量に基づいて内燃機関を制御することを特徴とする請求項１５に記載の内燃機関の制御装置。

【請求項１７】　吸気弁及び排気弁の少なくとも一方のための可変動弁機構を具備し、その可変動弁機構によって変更せしめられる吸気弁の開口面積に基づいて筒内乱れの程度を推定し、その筒内乱れの程度に基づいて内燃機関を制御するようにした内燃機関の制御装置において、可変動弁機構によって変更せしめられる吸気弁の開口面積が減少するに従って筒内乱れの程度が増加すると推定し、その推定された筒内乱れの程度に基づいて内燃機関を制御することを特徴とする内燃機関の制御装置。

【請求項１８】　吸気弁の作用角、吸気弁の位相、吸気管内の圧力、及び機関回転数に基づいて筒内乱れの程度を推定し、その推定された筒内乱れの程度に基づいて内燃機関を制御することを特徴とする請求項１７に記載の内燃機関の制御装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は内燃機関の制御装置に関する。

【０００２】

【従来の技術】従来、筒内圧に基づいて内燃機関を制御するようにした内燃機関の制御装置が知られている。この種の内燃機関の制御装置の例としては、例えば特開平９－５３５０３号公報に記載されたものがある。特開平９－５３５０３号公報に記載された内燃機関の制御装置では、筒内圧を検出するための筒内圧センサの出力値に基づいて燃料噴射量、点火時期が算出され、その算出された燃料噴射量、点火時期に基づいて内燃機関が制御されている。

【０００３】

【発明が解決しようとする課題】ところが、特開平９－５３５０３号公報に記載された内燃機関の制御装置のように筒内圧センサによって筒内圧が検出される場合、その検出された筒内圧は、燃焼圧がピークとなる時点のものであって、圧縮上死点後１０～１５クランク角度の時点のものになる。従って、特開平９－５３５０３号公報に記載された内燃機関の制御装置によっては、例えば圧縮上死点時の筒内圧のような、燃焼圧ピーク時以外の時点の筒内圧に基づいて内燃機関を制御することができない。その上、例えば可変動弁機構によって吸排気弁の開口面積又は作用角が変更せしめられるのに伴って筒内圧が変化してしまうのを考慮していない特開平９－５３５０３号公報に記載された内燃機関の制御装置によっては、吸排気弁の開口面積又は作用角が変更せしめられる場合に内燃機関を適切に制御することができない。

【０００４】また従来、気筒内のある部分の温度に基づいて内燃機関を制御するようにした内燃機関の制御装置が知られている。この種の内燃機関の制御装置の例としては、例えば特開平４－８１５７４号公報に記載されたものがある。特開平４－８１５７４号公報に記載された内燃機関の制御装置では、シリンダ壁温を検出するための壁温センサの出力値に基づいて点火時期が算出され、その算出された点火時期に基づいて内燃機関が制御されている。

【０００５】ところで、上述したように特開平４－８１５７４号公報に記載された内燃機関の制御装置ではシリンダ壁温に基づいて点火時期が算出され、その点火時期に基づいて内燃機関が制御されているものの、シリンダ壁温と筒内ガス温度とではかなりの相違があり、また、適切な点火時期はシリンダ壁温よりも、むしろ筒内ガス温度に基づいて定まるといえる。従って、シリンダ壁温に基づいて点火時期が算出されている特開平４－８１５７４号公報に記載された内燃機関の制御装置によっては、内燃機関を適切に制御することができない。その上、例えば可変動弁機構によって吸排気弁の開口面積又は作用角が変更せしめられるのに伴って筒内ガス温度が変化してしまうのを考慮していない特開平４－８１５７４号公報に記載された内燃機関の制御装置によっては、吸排気弁の開口面積又は作用角が変更せしめられる場合に内燃機関を適切に制御することができない。

【０００６】また従来、吸気弁及び排気弁の少なくとも一方のための可変動弁機構を具備し、内部ＥＧＲガス割合又は量に基づいて内燃機関を制御するようにした内燃機関の制御装置が知られている。この種の内燃機関の制御装置の例としては、例えば特開平９－２０９８９５号公報に記載されたものがある。特開平９－２０９８９５号公報に記載された内燃機関の制御装置では、吸気弁の開弁期間の長さを変更することなく開閉タイミング（バルブタイミング）をシフトさせる可変動弁機構が設けられ、内部ＥＧＲガス量（内部排気ガス再循環量）、つまり、吸気管内に吹き返された後に再び気筒内に吸入される既燃ガスの量と気筒から排出されることなく気筒内にそのまま残留している既燃ガスの量との和に基づいて点火時期が算出され、その算出された点火時期に基づいて内燃機関が制御されている。

【０００７】ところが、特開平９－２０９８９５号公報に記載された内燃機関の制御装置では、内部ＥＧＲガス量を算出する場合に吸排気弁の開閉タイミングのシフト量が考慮されているものの、吸排気弁の開口面積の変更量が考慮されていない。一方で、可変動弁機構にバルブリフト量を変更する機能が設けられ、バルブリフト量を変更することによって吸排気弁の開口面積が変更せしめられる場合には、吸排気弁の開閉タイミングがシフトされなくても、実際の内部ＥＧＲガス量はかなり変動する。従って、吸排気弁の開口面積が変更せしめられる場

合に、特開平９－２０９８９５号公報に記載された内燃機関の制御装置によって吸排気弁の開口面積の変更を考慮することなく内部ＥＧＲガス量が算出されてしまうと、算出された内部ＥＧＲガス量と実際の内部ＥＧＲガス量とがかなり相違してしまう。つまり、例えば可変動弁機構によって吸排気弁の開口面積が変更せしめられるのに伴って内部ＥＧＲガス量が変化してしまうのを考慮していない特開平９－２０９８９５号公報に記載された内燃機関の制御装置によっては、吸排気弁の開口面積が変更せしめられる場合に内部ＥＧＲガス量を正確に算出することができず、内燃機関を適切に制御することができない。

【０００８】また、特開平９－２０９８９５号公報に記載された内燃機関の制御装置では、内部ＥＧＲガス量を算出する場合に吸排気弁の開閉タイミングのシフト量が考慮されているものの、吸排気弁の作用角の変更量、つまり、吸排気弁の開弁期間に相当するカムシャフトの回転角の変更量が考慮されていない。一方で、可変動弁機構に吸排気弁の作用角を変更する機能、つまり、吸排気弁の開弁期間を増減させる機能が設けられ、吸排気弁の作用角が変更せしめられる場合には、吸排気弁の開閉タイミングがシフトされなくても、つまり、バルブリフト量のピークタイミングが変更されなくても、実際の内部ＥＧＲガス量はかなり変動する。従って、吸排気弁の作用角が変更せしめられる場合に、特開平９－２０９８９５号公報に記載された内燃機関の制御装置によって吸排気弁の作用角の変更を考慮することなく内部ＥＧＲガス量が算出されてしまうと、算出された内部ＥＧＲガス量と実際の内部ＥＧＲガス量とがかなり相違してしまう。つまり、例えば可変動弁機構によって吸排気弁の作用角が変更せしめられるのに伴って内部ＥＧＲガス量が変化してしまうのを考慮していない特開平９－２０９８９５号公報に記載された内燃機関の制御装置によっては、吸排気弁の作用角が変更せしめられる場合に内部ＥＧＲガス量を正確に算出することができず、内燃機関を適切に制御することができない。

【０００９】また従来、吸気弁及び排気弁の少なくとも一方のための可変動弁機構を具備し、その可変動弁機構によって変更せしめられる吸気弁の開口面積に基づいて筒内乱れの程度を推定し、その筒内乱れの程度に基づいて内燃機関を制御するようにした内燃機関の制御装置が知られている。この種の内燃機関の制御装置の例としては、例えば特開２０００－７３８００号公報に記載されたものがある。特開平２０００－７３８００号公報に記載された内燃機関の制御装置では、可変動弁機構によって変更せしめられる吸気弁の開口面積が減少するに従って筒内乱れの程度が減少すると推定されている。

【００１０】ところが、特開２０００－７３８００号公報に記載された内燃機関の制御装置では、可変動弁機構によって変更せしめられる吸気弁の開口面積が減少するに従って筒内乱れの程度が減少すると推定されているものの、現実には、可変動弁機構によって変更せしめられる吸気弁の開口面積が減少するに従って筒内乱れの程度は増加する。従って、特開２０００－７３８００号公報に記載された内燃機関の制御装置の場合のように吸気弁の開口面積が減少するに従って筒内乱れの程度が減少すると推定し、その推定された筒内乱れの程度に基づいて内燃機関を制御してしまうと、可変動弁機構によって吸気弁の開口面積が変更せしめられたときに内燃機関が適切に制御されなくなってしまう。

【００１１】前記問題点に鑑み、本発明は燃焼圧ピーク時の筒内圧のみならず、燃焼圧ピーク時以外の時点の筒内圧にも基づいて内燃機関を制御することができ、吸排気弁の開口面積又は作用角が変更せしめられる場合であっても内燃機関を適切に制御することができる内燃機関の制御装置を提供することを目的とする。

【００１２】更に本発明はシリンダ壁温に基づいて内燃機関が制御される場合よりも内燃機関を適切に制御し、吸排気弁の開口面積又は作用角が変更せしめられる場合であっても内燃機関を適切に制御することができる内燃機関の制御装置を提供することを目的とする。

【００１３】更に本発明は吸排気弁の開口面積又は作用角が変更せしめられる場合であっても内部ＥＧＲガス量を正確に算出し、内燃機関を適切に制御することができる内燃機関の制御装置を提供することを目的とする。

【００１４】更に本発明は可変動弁機構によって吸気弁の開口面積が変更せしめられた場合であっても筒内乱れの程度を正確に推定し内燃機関を適切に制御することができる内燃機関の制御装置を提供することを目的とする。

【００１５】

【課題を解決するための手段】請求項１に記載の発明によれば、筒内圧に基づいて内燃機関を制御するようにした内燃機関の制御装置において、吸気弁及び排気弁の少なくとも一方の開口面積を変更するための可変動弁機構を具備し、その可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の開口面積に基づいて筒内圧を算出し、その筒内圧に基づいて内燃機関を制御することを特徴とする内燃機関の制御装置が提供される。

【００１６】請求項１に記載の内燃機関の制御装置では、可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の開口面積に基づいて筒内圧が算出される。そのため、特開平９－５３５０３号公報に記載された内燃機関の制御装置のように筒内圧センサによって筒内圧が検出される場合と異なり、燃焼圧ピーク時の筒内圧のみならず燃焼圧ピーク時以外の時点の筒内圧にも基づいて内燃機関を制御することができる。更に、吸気弁及び排気弁の少なくとも一方の開口面積に基づいて算出される筒内圧に応じて内燃機関が制御される

ため、吸排気弁の開口面積が変更せしめられる場合であっても内燃機関を適切に制御することができる。詳細には例えば、吸気弁の開口面積が増加するに従って、吸気弁の開口面積に基づいて算出される筒内圧が増加し、筒内圧が増加するに従って点火時期が遅角せしめられるように内燃機関が制御される。あるいは、吸気弁の開口面積が増加するに従って、吸気弁の開口面積に基づいて算出される筒内圧が増加し、筒内圧が増加するに従って燃料噴射量が増加せしめられるように内燃機関が制御される。

【００１７】請求項２に記載の発明によれば、筒内圧に基づいて内燃機関を制御するようにした内燃機関の制御装置において、吸気弁及び排気弁の少なくとも一方の作用角を変更するための可変動弁機構を具備し、その可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の作用角に基づいて筒内圧を算出し、その筒内圧に基づいて内燃機関を制御することを特徴とする内燃機関の制御装置が提供される。

【００１８】請求項２に記載の内燃機関の制御装置では、可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の作用角に基づいて筒内圧が算出される。そのため、特開平９－５３５０３号公報に記載された内燃機関の制御装置のように筒内圧センサによって筒内圧が検出される場合と異なり、燃焼圧ピーク時の筒内圧のみならず燃焼圧ピーク時以外の時点の筒内圧にも基づいて内燃機関を制御することができる。更に、吸気弁及び排気弁の少なくとも一方の作用角に基づいて算出される筒内圧に応じて内燃機関が制御されるため、吸排気弁の作用角が変更せしめられる場合であっても内燃機関を適切に制御することができる。詳細には例えば、吸気下死点以降に吸気弁が全閉する場合には、吸気弁の作用角が減少するに従って、吸気弁の作用角に基づいて算出される筒内圧が増加し、筒内圧が増加するに従って点火時期が遅角せしめられるように内燃機関が制御される。また、吸気下死点以前に吸気弁が全閉する場合には、吸気弁の作用角が増加するに従って、吸気弁の作用角に基づいて算出される筒内圧が増加し、筒内圧が増加するに従って点火時期が遅角せしめられるように内燃機関が制御される。あるいは、吸気弁の作用角が減少するに従って、吸気弁の作用角に基づいて算出される筒内圧が増加し、筒内圧が増加するに従って燃料噴射量が増加せしめられるように内燃機関が制御される。

【００１９】請求項３に記載の発明によれば、吸気弁及び排気弁の少なくとも一方の開口面積及び作用角を変更するための可変動弁機構を具備し、その可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の開口面積及び作用角に基づいて筒内圧を算出し、その筒内圧に基づいて内燃機関を制御することを特徴とする請求項１又は２に記載の内燃機関の制御装置が提供される。

【００２０】請求項３に記載の内燃機関の制御装置では、可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の開口面積及び作用角に基づいて筒内圧が算出され、その筒内圧に基づいて内燃機関が制御される。そのため、吸排気弁の作用角に基づくことなく吸排気弁の開口面積のみに基づいて筒内圧が算出される場合や、吸排気弁の開口面積に基づくことなく吸排気弁の作用角のみに基づいて筒内圧が算出される場合よりも、筒内圧を正確に算出し、内燃機関を適切に制御することができる。

【００２１】請求項４に記載の発明によれば、吸気弁の位相、吸気管内の圧力、及び機関回転数に基づいて筒内圧を算出し、その筒内圧に基づいて内燃機関を制御することを特徴とする請求項３に記載の内燃機関の制御装置が提供される。

【００２２】請求項４に記載の内燃機関の制御装置では、吸気弁の位相、吸気管内の圧力、及び機関回転数に基づいて筒内圧が算出され、その筒内圧に基づいて内燃機関が制御される。そのため、吸気弁の位相、吸気管内の圧力、及び機関回転数に基づいて筒内圧が算出されない場合よりも筒内圧を正確に算出し、内燃機関を適切に制御することができる。

【００２３】請求項５に記載の発明によれば、気筒内のある部分の温度に基づいて内燃機関を制御するようにした内燃機関の制御装置において、吸気弁及び排気弁の少なくとも一方の開口面積を変更するための可変動弁機構を具備し、その可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の開口面積に基づいて筒内ガス温度を算出し、その筒内ガス温度に基づいて内燃機関を制御することを特徴とする内燃機関の制御装置が提供される。

【００２４】請求項５に記載の内燃機関の制御装置では、可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の開口面積に基づいて筒内ガス温度が算出され、その筒内ガス温度に基づいて内燃機関が制御される。そのため、特開平４－８１５７４号公報に記載された内燃機関の制御装置のようにシリンダ壁温に基づいて内燃機関が制御される場合よりも内燃機関を適切に制御することができる。更に、吸気弁及び排気弁の少なくとも一方の開口面積に基づいて算出される筒内ガス温度に応じて内燃機関が制御されるため、吸排気弁の開口面積が変更せしめられる場合であっても内燃機関を適切に制御することができる。詳細には例えば、吸気弁の開口面積が増加するに従って、吸気弁の開口面積に基づいて算出される筒内ガス温度が高くなり、筒内ガス温度が高くなるに従って点火時期が遅角せしめられるように内燃機関が制御される。

【００２５】請求項６に記載の発明によれば、気筒内のある部分の温度に基づいて内燃機関を制御するようにした内燃機関の制御装置において、吸気弁及び排気弁の少

なくとも一方の作用角を変更するための可変動弁機構を具備し、その可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の作用角に基づいて筒内ガス温度を算出し、その筒内ガス温度に基づいて内燃機関を制御することを特徴とする内燃機関の制御装置が提供される。

【００２６】請求項６に記載の内燃機関の制御装置では、可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の作用角に基づいて筒内ガス温度が算出され、その筒内ガス温度に基づいて内燃機関が制御される。そのため、特開平４－８１５７４号公報に記載された内燃機関の制御装置のようにシリンダ壁温に基づいて内燃機関が制御される場合よりも内燃機関を適切に制御することができる。更に、吸気弁及び排気弁の少なくとも一方の作用角に基づいて算出される筒内ガス温度に応じて内燃機関が制御されるため、吸排気弁の作用角が変更せしめられる場合であっても内燃機関を適切に制御することができる。詳細には例えば、吸気下死点以降に吸気弁が全閉する場合には、吸気弁の作用角が増加するに従って、吸気弁の作用角に基づいて算出される筒内ガス温度が高くなり、筒内ガス温度が高くなるに従って点火時期が遅角せしめられるように内燃機関が制御される。また、吸気下死点以前に吸気弁が全閉する場合には、吸気弁の作用角が減少するに従って、吸気弁の作用角に基づいて算出される筒内ガス温度が高くなり、筒内ガス温度が高くなるに従って点火時期が遅角せしめられるように内燃機関が制御される。

【００２７】請求項７に記載の発明によれば、吸気弁及び排気弁の少なくとも一方の開口面積及び作用角を変更するための可変動弁機構を具備し、その可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の開口面積及び作用角に基づいて筒内ガス温度を算出し、その筒内ガス温度に基づいて内燃機関を制御することを特徴とする請求項５又は６に記載の内燃機関の制御装置が提供される。

【００２８】請求項７に記載の内燃機関の制御装置では、可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の開口面積及び作用角に基づいて筒内ガス温度が算出され、その筒内ガス温度に基づいて内燃機関が制御される。そのため、吸排気弁の作用角に基づくことなく吸排気弁の開口面積のみに基づいて筒内ガス温度が算出される場合や、吸排気弁の開口面積に基づくことなく吸排気弁の作用角のみに基づいて筒内ガス温度が算出される場合よりも筒内ガス温度を正確に算出し、内燃機関を適切に制御することができる。

【００２９】請求項８に記載の発明によれば、吸気弁の位相、吸気管内の圧力、及び機関回転数に基づいて筒内ガス温度を算出し、その筒内ガス温度に基づいて内燃機関を制御することを特徴とする請求項７に記載の内燃機関の制御装置が提供される。

【００３０】請求項８に記載の内燃機関の制御装置では、吸気弁の位相、吸気管内の圧力、及び機関回転数に基づいて筒内ガス温度が算出され、その筒内ガス温度に基づいて内燃機関が制御される。そのため、吸気弁の位相、吸気管内の圧力、及び機関回転数に基づいて筒内ガス温度が算出されない場合よりも筒内ガス温度を正確に算出し、内燃機関を適切に制御することができる。

【００３１】請求項９に記載の発明によれば、シリンダ壁温、機関回転数、吸入空気量、内部ＥＧＲガス量、内部ＥＧＲガス温度のうちの少なくとも一つに基づいて筒内ガス温度を補正することを特徴とする請求項５～８のいずれか一項に記載の内燃機関の制御装置が提供される。

【００３２】請求項９に記載の内燃機関の制御装置では、シリンダ壁温、機関回転数、吸入空気量、内部ＥＧＲガス量、内部ＥＧＲガス温度のうちの少なくとも一つに基づいて筒内ガス温度が補正されるため、それらのうちの少なくとも一つに基づいて筒内ガス温度が補正されない場合よりも内燃機関を適切に制御することができる。

【００３３】請求項１０に記載の発明によれば、吸気弁及び排気弁の少なくとも一方のための可変動弁機構を具備し、内部ＥＧＲガス割合又は量に基づいて内燃機関を制御するようにした内燃機関の制御装置において、可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の開口面積に基づいて内部ＥＧＲガス割合又は量を算出し、その内部ＥＧＲガス割合又は量に基づいて内燃機関を制御することを特徴とする内燃機関の制御装置が提供される。

【００３４】請求項１０に記載の内燃機関の制御装置では、可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の開口面積に基づいて内部ＥＧＲガス割合又は量が算出され、その内部ＥＧＲガス割合又は量に基づいて内燃機関が制御される。そのため、特開平９－２０９８９５号公報に記載された内燃機関の制御装置のように可変動弁機構による吸排気弁の開口面積の変更を考慮することなく内部ＥＧＲガス割合又は量が算出される場合よりも、内部ＥＧＲガス割合又は量を正確に算出し、内燃機関を適切に制御することができる。つまり、吸排気弁の開口面積が変更せしめられる場合であっても内部ＥＧＲガス量を正確に算出し、内燃機関を適切に制御することができる。詳細には例えば、吸気弁の開口面積が増加するに従って、吸気弁の開口面積に基づいて算出される内部ＥＧＲガス割合又は量が増加し、内部ＥＧＲガス割合又は量が増加するに従って点火時期が進角せしめられるように内燃機関が制御される。

【００３５】請求項１１に記載の発明によれば、吸気弁及び排気弁の少なくとも一方のための可変動弁機構を具備し、内部ＥＧＲガス割合又は量に基づいて内燃機関を制御するようにした内燃機関の制御装置において、可変

動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の作用角に基づいて内部ＥＧＲガス割合又は量を算出し、その内部ＥＧＲガス割合又は量に基づいて内燃機関を制御することを特徴とする内燃機関の制御装置が提供される。

【００３６】請求項１１に記載の内燃機関の制御装置では、可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の作用角に基づいて内部ＥＧＲガス割合又は量が算出され、その内部ＥＧＲガス割合又は量に基づいて内燃機関が制御される。そのため、特開平９－２０９８９５号公報に記載された内燃機関の制御装置のように可変動弁機構による吸排気弁の作用角の変更を考慮することなく内部ＥＧＲガス割合又は量が算出される場合よりも、内部ＥＧＲガス割合又は量を正確に算出し、内燃機関を適切に制御することができる。つまり、吸排気弁の作用角が変更せしめられる場合であっても内部ＥＧＲガス量を正確に算出し、内燃機関を適切に制御することができる。詳細には例えば、吸気弁の作用角が増加するに従って、吸気弁の作用角に基づいて算出される内部ＥＧＲガス割合又は量が増加し、内部ＥＧＲガス割合又は量が増加するに従って点火時期が進角せしめられるように内燃機関が制御される。

【００３７】請求項１２に記載の発明によれば、可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の開口面積及び作用角に基づいて内部ＥＧＲガス割合又は量を算出し、その内部ＥＧＲガス割合又は量に基づいて内燃機関を制御することを特徴とする請求項１０又は１１に記載の内燃機関の制御装置が提供される。

【００３８】請求項１２に記載の内燃機関の制御装置では、可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の開口面積及び作用角に基づいて内部ＥＧＲガス割合又は量が算出され、その内部ＥＧＲガス割合又は量に基づいて内燃機関が制御される。そのため、吸排気弁の作用角に基づくことなく吸排気弁の開口面積のみに基づいて内部ＥＧＲガス割合又は量が算出される場合や、吸排気弁の開口面積に基づくことなく吸排気弁の作用角のみに基づいて内部ＥＧＲガス割合又は量が算出される場合よりも、内部ＥＧＲガス割合又は量を正確に算出し、内燃機関を適切に制御することができる。

【００３９】請求項１３に記載の発明によれば、吸気弁の位相、吸気管内の圧力、及び機関回転数に基づいて内部ＥＧＲガス割合又は量を算出し、その内部ＥＧＲガス割合又は量に基づいて内燃機関を制御することを特徴とする請求項１２に記載の内燃機関の制御装置が提供される。

【００４０】請求項１３に記載の内燃機関の制御装置では、吸気弁の位相、吸気管内の圧力、及び機関回転数に基づいて内部ＥＧＲガス割合又は量が算出され、その内部ＥＧＲガス割合又は量に基づいて内燃機関が制御される。そのため、吸気弁の位相、吸気管内の圧力、及び機関回転数に基づいて内部ＥＧＲガス割合又は量が算出されない場合よりも、内部ＥＧＲガス割合又は量を正確に算出し、内燃機関を適切に制御することができる。

【００４１】請求項１４に記載の発明によれば、大気圧、排気管内の圧力、及び前回算出した内部ＥＧＲガス割合又は量のうちの少なくとも一つに基づいて内部ＥＧＲガス割合又は量を補正することを特徴とする請求項１０～１３のいずれか一項に記載の内燃機関の制御装置が提供される。

【００４２】請求項１４に記載の内燃機関の制御装置では、大気圧、排気管内の圧力、及び前回算出した内部ＥＧＲガス割合又は量のうちの少なくとも一つに基づいて内部ＥＧＲガス割合又は量が補正されるため、それらのうちの少なくとも一つに基づいて内部ＥＧＲガス割合又は量が補正されない場合よりも内燃機関を適切に制御することができる。

【００４３】請求項１５に記載の発明によれば、可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の開口面積と、バルブオーバラップ期間中における吸気弁の上流側の圧力及び下流側の圧力とに基づいて内部ＥＧＲガス割合又は量を算出し、その内部ＥＧＲガス割合又は量に基づいて内燃機関を制御することを特徴とする請求項１０に記載の内燃機関の制御装置が提供される。

【００４４】請求項１５に記載の内燃機関の制御装置では、可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の開口面積と、バルブオーバラップ期間中における吸気弁の上流側の圧力及び下流側の圧力とに基づいて内部ＥＧＲガス割合又は量が算出され、その内部ＥＧＲガス割合又は量に基づいて内燃機関が制御される。そのため、可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の開口面積のみに基づいて内部ＥＧＲガス割合又は量が算出され、バルブオーバラップ期間中における吸気弁の上流側の圧力及び下流側の圧力に基づいて内部ＥＧＲガス割合又は量が算出されない場合よりも、内部ＥＧＲガス割合又は量を正確に算出し、内燃機関を適切に制御することができる。

【００４５】請求項１６に記載の発明によれば、可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の所定時間毎の開口面積と、バルブオーバラップ期間中における所定時間毎の吸気弁の上流側の圧力及び下流側の圧力とに基づいて瞬時内部ＥＧＲガス割合又は量を算出し、その瞬時内部ＥＧＲガス割合又は量を積算することにより得られた内部ＥＧＲガス割合又は量に基づいて内燃機関を制御することを特徴とする請求項１５に記載の内燃機関の制御装置が提供される。

【００４６】請求項１６に記載の内燃機関の制御装置で

は、可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の所定時間毎の開口面積と、バルブオーバラップ期間中における所定時間毎の吸気弁の上流側の圧力及び下流側の圧力とに基づいて瞬時内部ＥＧＲガス割合又は量が算出され、その瞬時内部ＥＧＲガス割合又は量を積算することにより得られた内部ＥＧＲガス割合又は量に基づいて内燃機関が制御される。そのため、吸排気弁の開口面積やバルブオーバラップ期間中における吸気弁の上流側の圧力及び下流側の圧力の変化が大きい場合であっても、内部ＥＧＲガス割合又は量を正確に算出し、内燃機関を適切に制御することができる。

【００４７】請求項１７に記載の発明によれば、吸気弁及び排気弁の少なくとも一方のための可変動弁機構を具備し、その可変動弁機構によって変更せしめられる吸気弁の開口面積に基づいて筒内乱れの程度を推定し、その筒内乱れの程度に基づいて内燃機関を制御するようにした内燃機関の制御装置において、可変動弁機構によって変更せしめられる吸気弁の開口面積が減少するに従って筒内乱れの程度が増加すると推定し、その推定された筒内乱れの程度に基づいて内燃機関を制御することを特徴とする内燃機関の制御装置が提供される。

【００４８】請求項１７に記載の内燃機関の制御装置では、可変動弁機構によって変更せしめられる吸気弁の開口面積が減少するに従って筒内乱れの程度が増加すると推定され、その推定された筒内乱れの程度に基づいて内燃機関が制御される。そのため、吸気弁の開口面積が減少するに従って筒内乱れの程度が減少すると推定され、その推定された筒内乱れの程度に基づいて内燃機関が制御される特開２０００－７３８００号公報に記載された内燃機関の制御装置と異なり、可変動弁機構によって吸気弁の開口面積が変更せしめられた場合であっても筒内乱れの程度を正確に推定し内燃機関を適切に制御することができる。詳細には例えば、吸気弁の開口面積が減少するに従って、吸気弁の開口面積に基づいて推定される筒内乱れの程度が増加し、筒内乱れの程度が増加するに従って点火時期が遅角せしめられるように内燃機関が制御される。

【００４９】請求項１８に記載の発明によれば、吸気弁の作用角、吸気弁の位相、吸気管内の圧力、及び機関回転数に基づいて筒内乱れの程度を推定し、その推定された筒内乱れの程度に基づいて内燃機関を制御することを特徴とする請求項１７に記載の内燃機関の制御装置が提供される。

【００５０】請求項１８に記載の内燃機関の制御装置では、吸気弁の位相、吸気管内の圧力、及び機関回転数に基づいて筒内乱れの程度が推定され、その推定された筒内乱れの程度に基づいて内燃機関が制御される。そのため、吸気弁の位相、吸気管内の圧力、及び機関回転数に基づいて筒内乱れの程度が推定されない場合よりも、筒内乱れの程度を正確に推定し、内燃機関を適切に制御することができる。

【００５１】

【発明の実施の形態】以下、添付図面を用いて本発明の実施形態について説明する。

【００５２】図１は本発明の内燃機関の制御装置の第一の実施形態の概略構成図、図２は図１に示した内燃機関の制御装置の吸気系等の詳細図である。図１及び図２において、１は内燃機関、２は吸気弁、３は排気弁、４は吸気弁を開閉させるためのカム、５は排気弁を開閉させるためのカム、６は吸気弁用カム４を担持しているカムシャフト、７は排気弁用カム５を担持しているカムシャフトである。図３は図１に示した吸気弁用カム及びカムシャフトの詳細図である。図３に示すように、本実施形態のカム４のカムプロフィルは、カムシャフト中心軸線の方向に変化している。つまり、本実施形態のカム４は、図３の左端のノーズ高さが右端のノーズ高さよりも大きくなっている。すなわち、本実施形態の吸気弁２のバルブリフト量は、バルブリフタがカム４の左端と接しているときよりも、バルブリフタがカム４の右端と接しているときの方が小さくなる。

【００５３】図１及び図２の説明に戻り、８は気筒内に形成された燃焼室、９はバルブリフト量を変更するために吸気弁２に対してカム４をカムシャフト中心軸線の方向に移動させるためのバルブリフト量変更装置である。つまり、バルブリフト量変更装置９を作動することにより、カム４の左端（図３）においてカム４とバルブリフタとを接触させたり、カム４の右端（図３）においてカム４とバルブリフタとを接触させたりすることができる。バルブリフト量変更装置９によって吸気弁２のバルブリフト量が変更されると、それに伴って、吸気弁２の開口面積が変更されることになる。本実施形態の吸気弁２では、バルブリフト量が増加されるに従って吸気弁２の開口面積が増加するようになっている。１０はバルブリフト量変更装置９を駆動するためのドライバ、１１は吸気弁２の開弁期間を変更することなく吸気弁の開閉タイミングをシフトさせるための開閉タイミングシフト装置である。つまり、開閉タイミングシフト装置１１を作動することにより、吸気弁２の開閉タイミングを進角側にシフトさせたり、遅角側にシフトさせたりすることができる。１２は開閉タイミングシフト装置１１を作動するための油圧を制御するオイルコントロールバルブである。尚、本実施形態における可変動弁機構には、バルブリフト量変更装置９及び開閉タイミングシフト装置１１の両者が含まれることになる。

【００５４】１３はクランクシャフト、１４はオイルパン、１５は燃料噴射弁、１６は吸気弁２のバルブリフト量及び開閉タイミングシフト量を検出するためのセンサ、１７は機関回転数を検出するためのセンサである。１８は気筒内に吸入空気を供給する吸気管内の圧力を検

出するための吸気管圧センサ、１９はエアフローメータ、２０は内燃機関冷却水の温度を検出するための冷却水温センサ、２１は気筒内に供給される吸入空気の吸気管内における温度を検出するための吸入空気温センサ、２２はＥＣＵ（電子制御装置）である。５０はシリンダ、５１，５２は吸気管、５３はサージタンク、５４は排気管、５５は点火栓である。

【００５５】図４は図１に示したバルブリフト量変更装置等の詳細図である。図４において、３０は吸気弁用カムシャフト６に連結された磁性体、３１は磁性体３０を左側に付勢するためのコイル、３２は磁性体３０を右側に付勢するための圧縮ばねである。コイル３１に対する通電量が増加されるに従って、カム４及びカムシャフト６が左側に移動する量が増加し、吸気弁２のバルブリフト量が減少せしめられることになる。

【００５６】図５はバルブリフト量変更装置が作動されるのに伴って吸気弁のバルブリフト量が変化する様子を示した図である。図５に示すように、コイル３１に対する通電量が減少されるに従って、吸気弁２のバルブリフト量が増加せしめられる（実線→破線→一点鎖線）。また本実施形態では、バルブリフト量変更装置９が作動されるのに伴って、吸気弁２の開弁期間も変更せしめられる。つまり、吸気弁２の作用角も変更せしめられる。詳細には、吸気弁２のバルブリフト量が増加せしめられるのに伴って、吸気弁２の作用角が増加せしめられる（実線→破線→一点鎖線）。更に本実施形態では、バルブリフト量変更装置９が作動されるのに伴って、吸気弁２のバルブリフト量がピークとなるタイミングも変更せしめられる。詳細には、吸気弁２のバルブリフト量が増加せしめられるのに伴って、吸気弁２のバルブリフト量がピークとなるタイミングが遅角せしめられる（実線→破線→一点鎖線）。

【００５７】図６は図１に示した開閉タイミングシフト装置等の詳細図である。図６において、４０は吸気弁２の開閉タイミングを進角側にシフトさせるための進角側油路、４１は吸気弁２の開閉タイミングを遅角側にシフトさせるための遅角側油路、４２はオイルポンプである。進角側油路４０内の油圧が増加されるに従い、吸気弁２の開閉タイミングが進角側にシフトせしめられる。つまり、クランクシャフト１３に対するカムシャフト６の回転位相が進角せしめられる。一方、遅角側油路４１の油圧が増加されるに従い、吸気弁２の開閉タイミングが遅角側にシフトせしめられる。つまり、クランクシャフト１３に対するカムシャフト６の回転位相が遅角せしめられる。

【００５８】図７は開閉タイミングシフト装置が作動されるのに伴って吸気弁の開閉タイミングがシフトする様子を示した図である。図７に示すように、進角側油路４０内の油圧が増加されるに従って吸気弁２の開閉タイミングが進角側にシフトされる（実線→破線→一点鎖線）。このとき、吸気弁２の開弁期間は変更されない、つまり、吸気弁２が開弁している期間の長さは変更されない。

【００５９】上述したようにバルブリフト量変更装置９及び開閉タイミングシフト装置１１によって吸気弁２のバルブリフト量、作用角、開閉タイミング（位相）が変更せしめられると、それに伴って筒内圧が変化する。筒内圧が変化するにもかかわらず一律に所定のタイミングで点火が行われてしまうと、最適な点火時期からずれてしまい、内燃機関を適切に制御することができない。従って、最適なタイミングで点火を行い、内燃機関を適切に制御するためには、吸気弁２のバルブリフト量、作用角、開閉タイミング（位相）の変更に伴って変化する筒内圧を正確に算出することが必要になる。

【００６０】図８は本実施形態における点火時期算出方法を示したフローチャートである。このルーチンは所定時間間隔で実行される。図８に示すように、このルーチンが開始されると、まずステップ１００において機関始動時であるか否かが判断される。ＹＥＳのときには、燃料増量が行われる機関始動時には筒内圧を正確に算出し、それに基づいて点火時期を決定する必要がないと判断し、このルーチンを終了する。一方、ＮＯのときにはステップ１０１に進む。ステップ１０１では、吸気弁２のバルブリフト量ＬＴ、作用角ＶＡ、開閉タイミングＶＴ、吸気管内の圧力ＰＭ、機関回転数ＮＥに基づいて圧縮上死点時筒内圧力標準状態ＰＣＹＬｂが算出される。

【００６１】図９は圧縮上死点時筒内圧力標準状態ＰＣＹＬｂとバルブリフト量ＬＴと吸気管内の圧力ＰＭとの関係を示した図である。図９に示すように、ステップ１０１において算出される圧縮上死点時筒内圧力標準状態ＰＣＹＬｂは、バルブリフト量ＬＴが大きくなるに従って高くなり、また、吸気管内の圧力ＰＭが高くなるに従って高くなる。図１０は圧縮上死点時筒内圧力標準状態ＰＣＹＬｂと作用角ＶＡと吸気管内の圧力ＰＭとの関係を示した図である。図１０に示すように、ステップ１０１において算出される圧縮上死点時筒内圧力標準状態ＰＣＹＬｂは、吸気下死点以降に吸気弁２が全閉する場合、作用角ＶＡが小さくなるに従って高くなる。図１１は圧縮上死点時筒内圧力標準状態ＰＣＹＬｂと作用角ＶＡと吸気管内の圧力ＰＭとの関係を示した図である。図１１に示すように、ステップ１０１において算出される圧縮上死点時筒内圧力標準状態ＰＣＹＬｂは、吸気下死点以前に吸気弁２が全閉する場合、作用角ＶＡが大きくなるに従って高くなる。

【００６２】図１２は圧縮上死点時筒内圧力標準状態ＰＣＹＬｂと開閉タイミング（位相）ＶＴと吸気管内の圧力ＰＭとの関係を示した図である。図１２に示すように、ステップ１０１において算出される圧縮上死点時筒内圧力標準状態ＰＣＹＬｂは、吸気下死点以降に吸気弁２が全閉する場合、開閉タイミング（位相）ＶＴが進角

せしめられるに従って高くなる。図１３は圧縮上死点時筒内圧力標準状態ＰＣＹＬｂと開閉タイミング（位相）ＶＴと吸気管内の圧力ＰＭとの関係を示した図である。図１３に示すように、ステップ１０１において算出される圧縮上死点時筒内圧力標準状態ＰＣＹＬｂは、吸気下死点以前に吸気弁２が全閉する場合、開閉タイミング（位相）ＶＴが遅角せしめられるに従って高くなる。図１４は圧縮上死点時筒内圧力標準状態ＰＣＹＬｂと機関回転数ＮＥとの関係を示した図である。図１４に示すように、ステップ１０１において算出される圧縮上死点時筒内圧力標準状態ＰＣＹＬｂは、機関回転数ＮＥが中速のときにピークとなる。

【００６３】図８の説明に戻り、次いでステップ１０２では、現在の機関運転条件に基づいて圧縮上死点時筒内圧力標準状態ＰＣＹＬｂから圧縮上死点時筒内圧力ＰＣＹＬが算出される。次いでステップ１０３では、圧縮上死点時筒内圧力ＰＣＹＬと、機関回転数ＮＥと、１回転当たり気筒内に吸入される吸入空気量ＧＮ、つまり、一回の吸気行程において気筒内に吸入される吸入空気量ＧＮとに基づいて点火時期ＳＡが算出される。図１５は点火時期ＳＡと圧縮上死点時筒内圧力ＰＣＹＬと１回転当たり気筒内に吸入される吸入空気量ＧＮとの関係を示した図である。図１５に示すように、ステップ１０３において算出される点火時期ＳＡは、圧縮上死点時筒内圧力ＰＣＹＬが高くなるに従って遅角せしめられ、１回転当たり気筒内に吸入される吸入空気量ＧＮが多くなるに従って遅角せしめられる。図１６は点火時期ＳＡと機関回転数ＮＥとの関係を示した図である。図１６に示すように、ステップ１０３において算出される点火時期ＳＡは、機関回転数ＮＥが高くなるに従って進角せしめられる。

【００６４】上述したように本実施形態では、図８のステップ１０１及びステップ１０２において、筒内圧（圧縮上死点時筒内圧力ＰＣＹＬ）が、可変動弁機構としてのバルブリフト量変更装置９によってバルブリフト量ＬＴが変更されるのに伴って変更せしめられる吸気弁２の開口面積に基づいて算出され、その筒内圧に基づいて内燃機関が制御される。従って本実施形態によれば、特開平９－５３５０３号公報に記載された内燃機関の制御装置のように筒内圧センサによって筒内圧が検出される場合と異なり、燃焼圧ピーク時の筒内圧のみならず燃焼圧ピーク時以外の時点の筒内圧にも基づいて内燃機関を制御することができる。更に、吸気弁２の開口面積が変更せしめられる場合であっても内燃機関を適切に制御することができる。詳細には、図９に示したように吸気弁２の開口面積が増加するに従って、吸気弁の開口面積に基づいて算出される筒内圧が増加し、図１５に示したように筒内圧が増加するに従って点火時期ＳＡが遅角せしめられるように内燃機関が制御される。

【００６５】更に本実施形態では、図８のステップ１０１及びステップ１０２において、筒内圧（圧縮上死点時筒内圧力ＰＣＹＬ）が、可変動弁機構としてのバルブリフト量変更装置９によって変更せしめられる吸気弁２の作用角ＶＡに基づいて算出され、その筒内圧に基づいて内燃機関が制御される。従って本実施形態によれば、特開平９－５３５０３号公報に記載された内燃機関の制御装置のように筒内圧センサによって筒内圧が検出される場合と異なり、燃焼圧ピーク時の筒内圧のみならず燃焼圧ピーク時以外の時点の筒内圧にも基づいて内燃機関を制御することができる。更に、吸気弁２の作用角ＶＡが変更せしめられる場合であっても内燃機関を適切に制御することができる。詳細には、図１０に示したように吸気下死点以降に吸気弁２が全閉する場合には、吸気弁２の作用角ＶＡが減少するに従って、吸気弁２の作用角ＶＡに基づいて算出される筒内圧が増加し、図１５に示したように筒内圧が増加するに従って点火時期ＳＡが遅角せしめられるように内燃機関が制御される。また、図１１に示したように吸気下死点以前に吸気弁２が全閉する場合には、吸気弁２の作用角ＶＡが増加するに従って、吸気弁２の作用角ＶＡに基づいて算出される筒内圧が増加し、図１５に示したように筒内圧が増加するに従って点火時期ＳＡが遅角せしめられるように内燃機関が制御される。

【００６６】また本実施形態では、図８のステップ１０１及びステップ１０２において、筒内圧（圧縮上死点時筒内圧力ＰＣＹＬ）が、可変動弁機構としてのバルブリフト量変更装置９によって変更せしめられる吸気弁２の開口面積及び作用角ＶＡの両方に基づいて算出され、その筒内圧に基づいて内燃機関が制御される。従って本実施形態によれば、吸気弁２の作用角ＶＡに基づくことなく吸気弁２の開口面積のみに基づいて筒内圧が算出される場合や、吸気弁２の開口面積に基づくことなく吸気弁２の作用角ＶＡのみに基づいて筒内圧が算出される場合よりも、筒内圧を正確に算出し、内燃機関を適切に制御することができる。

【００６７】また本実施形態では、図８のステップ１０１及びステップ１０２において、筒内圧（圧縮上死点時筒内圧力ＰＣＹＬ）が、吸気弁２の開閉タイミング（位相）ＶＴ、吸気管内の圧力ＰＭ、及び機関回転数ＮＥに基づいて算出され、その筒内圧に基づいて内燃機関が制御される。従って本実施形態によれば、吸気弁２の開閉タイミング（位相）ＶＴ、吸気管内の圧力ＰＭ、及び機関回転数ＮＥに基づいて筒内圧が算出されない場合よりも筒内圧を正確に算出し、内燃機関を適切に制御することができる。

【００６８】尚、本実施形態では吸気弁の開口面積等に基づいて筒内圧を算出し、その筒内圧に基づいて内燃機関が制御されているが、他の実施形態では、排気弁の開口面積等に基づいて筒内圧を算出し、その筒内圧に基づいて内燃機関を制御することも可能である。つまり、本

発明は、吸気弁のみならず排気弁にも適用可能である。

【0069】以下、本発明の内燃機関の制御装置の第二の実施形態について説明する。本実施形態の構成は図1～図7に示した第一の実施形態の構成とほぼ同様である。本実施形態においても、バルブリフト量変更装置9及び開閉タイミングシフト装置11によって吸気弁2のバルブリフト量、作用角、開閉タイミング（位相）が変更せしめられると、それに伴って筒内圧が変化する。筒内圧が変化するにもかかわらず一律に燃料噴射量が定められてしまうと、実際の空燃比が目標空燃比からずれてしまい、内燃機関を適切に制御することができない。従って、最適な燃料噴射量を算出し、内燃機関を適切に制御するためには、吸気弁２のバルブリフト量、作用角、開閉タイミング（位相）の変更に伴って変化する筒内圧を正確に算出することが必要になる。

【0070】図１７は本実施形態における燃料噴射量算出方法を示したフローチャートである。このルーチンは所定時間間隔で実行される。図１７に示すように、このルーチンが開始されると、まずステップ２００において機関始動時であるか否かが判断される。ＹＥＳのときには、燃料増量が行われる機関始動時には燃料噴射量が筒内圧とは無関係に定まるため、燃料噴射量を決定するために筒内圧を正確に算出する必要がないと判断し、このルーチンを終了する。一方、ＮＯのときにはステップ２０１に進む。ステップ２０１では、吸気弁２のバルブリフト量ＬＴ、作用角ＶＡ、開閉タイミングＶＴ、吸気管内の圧力ＰＭ、機関回転数ＮＥに基づいて吸気下死点時筒内圧力標準状態ＰＣＹＬＩＮｂが算出される。

【0071】図１８は吸気下死点時筒内圧力標準状態ＰＣＹＬＩＮｂとバルブリフト量ＬＴと吸気管内の圧力ＰＭとの関係を示した図である。図１８に示すように、ステップ２０１において算出される吸気下死点時筒内圧力標準状態ＰＣＹＬＩＮｂは、バルブリフト量ＬＴが大きくなるに従って高くなり、また、吸気管内の圧力ＰＭが高くなるに従って高くなる。図１９は吸気下死点時筒内圧力標準状態ＰＣＹＬＩＮｂと作用角ＶＡと吸気管内の圧力ＰＭとの関係を示した図である。図１９に示すように、ステップ２０１において算出される吸気下死点時筒内圧力標準状態ＰＣＹＬＩＮｂは、作用角ＶＡが小さくなるに従って高くなる。

【0072】図２０は吸気下死点時筒内圧力標準状態ＰＣＹＬＩＮｂと開閉タイミング（位相）ＶＴと吸気管内の圧力ＰＭとの関係を示した図である。図２０に示すように、ステップ２０１において算出される吸気下死点時筒内圧力標準状態ＰＣＹＬＩＮｂは、開閉タイミング（位相）ＶＴが進角せしめられるに従って高くなる。図２１は吸気下死点時筒内圧力標準状態ＰＣＹＬＩＮｂと機関回転数ＮＥとの関係を示した図である。図２１に示すように、ステップ２０１において算出される吸気下死点時筒内圧力標準状態ＰＣＹＬＩＮｂは、機関回転数ＮＥが中速のときにピークとなる。

【0073】図１７の説明に戻り、次いでステップ２０２では、現在の機関運転条件に基づいて吸気下死点時筒内圧力標準状態ＰＣＹＬＩＮｂから吸気下死点時筒内圧力ＰＣＹＬＩＮが算出される。次いでステップ２０３では、吸気下死点時筒内圧力ＰＣＹＬＩＮと開閉タイミング（位相、バルブオーバラップ）ＶＴとに基づいて燃料噴射量ＱＩＮＪが算出される。図２２は燃料噴射量ＱＩＮＪと吸気下死点時筒内圧力ＰＣＹＬＩＮと開閉タイミング（位相、バルブオーバラップ）ＶＴとの関係を示した図である。図２２に示すように、ステップ２０３において算出される燃料噴射量ＱＩＮＪは、吸気下死点時筒内圧力ＰＣＹＬＩＮが高くなるに従って増加せしめられ、開閉タイミング（位相）ＶＴが遅角されるに従って、つまり、吸気弁２と排気弁３とのバルブオーバラップ期間が減少されるに従って増加せしめられる。

【0074】上述したように本実施形態では、図１７のステップ２０１及びステップ２０２において、筒内圧（吸気下死点時筒内圧力ＰＣＹＬＩＮ）が、可変動弁機構としてのバルブリフト量変更装置９によってバルブリフト量ＬＴが変更されるのに伴って変更せしめられる吸気弁２の開口面積に基づいて算出され、その筒内圧に基づいて内燃機関が制御される。従って本実施形態によれば、特開平９－５３５０３号公報に記載された内燃機関の制御装置のように筒内圧センサによって筒内圧が検出される場合と異なり、燃焼圧ピーク時の筒内圧のみならず燃焼圧ピーク時以外の時点の筒内圧にも基づいて内燃機関を制御することができる。更に、吸気弁２の開口面積が変更せしめられる場合であっても内燃機関を適切に制御することができる。詳細には、図１８に示したように吸気弁２の開口面積が増加するに従って、吸気弁の開口面積に基づいて算出される筒内圧が増加し、図２２に示したように筒内圧が増加するに従って燃料噴射量ＱＩＮＪが増加せしめられるように内燃機関が制御される。

【0075】更に本実施形態では、図１７のステップ２０１及びステップ２０２において、筒内圧（吸気下死点時筒内圧力ＰＣＹＬＩＮ）が、可変動弁機構としてのバルブリフト量変更装置９によって変更せしめられる吸気弁２の作用角ＶＡに基づいて算出され、その筒内圧に基づいて内燃機関が制御される。従って本実施形態によれば、特開平９－５３５０３号公報に記載された内燃機関の制御装置のように筒内圧センサによって筒内圧が検出される場合と異なり、燃焼圧ピーク時の筒内圧のみならず燃焼圧ピーク時以外の時点の筒内圧にも基づいて内燃機関を制御することができる。更に、吸気弁２の作用角ＶＡが変更せしめられる場合であっても内燃機関を適切に制御することができる。詳細には、図１９に示したように吸気弁２の作用角ＶＡが減少するに従って、吸気弁２の作用角ＶＡに基づいて算出される筒内圧が増加し、図２２に示したように筒内圧が増加するに従って燃料噴

射量ＱＩＮＪが増加せしめられるように内燃機関が制御される。

【００７６】また本実施形態では、図１７のステップ２０１及びステップ２０２において、筒内圧（吸気下死点時筒内圧力ＰＣＹＬＩＮ）が、可変動弁機構としてのバルブリフト量変更装置９によって変更せしめられる吸気弁２の開口面積及び作用角ＶＡの両方に基づいて算出され、その筒内圧に基づいて内燃機関が制御される。従って本実施形態によれば、吸気弁２の作用角ＶＡに基づくことなく吸気弁２の開口面積のみに基づいて筒内圧が算出される場合や、吸気弁２の開口面積に基づくことなく吸気弁２の作用角ＶＡのみに基づいて筒内圧が算出される場合よりも、筒内圧を正確に算出し、内燃機関を適切に制御することができる。

【００７７】また本実施形態では、図１７のステップ２０１及びステップ２０２において、筒内圧（吸気下死点時筒内圧力ＰＣＹＬＩＮ）が、吸気弁２の開閉タイミング（位相）ＶＴ、吸気管内の圧力ＰＭ、及び機関回転数ＮＥに基づいて算出され、その筒内圧に基づいて内燃機関が制御される。従って本実施形態によれば、吸気弁２の開閉タイミング（位相）ＶＴ、吸気管内の圧力ＰＭ、及び機関回転数ＮＥに基づいて筒内圧が算出されない場合よりも筒内圧を正確に算出し、内燃機関を適切に制御することができる。

【００７８】尚、本実施形態では吸気弁の開口面積等に基づいて筒内圧を算出し、その筒内圧に基づいて内燃機関が制御されているが、他の実施形態では、排気弁の開口面積等に基づいて筒内圧を算出し、その筒内圧に基づいて内燃機関を制御することも可能である。つまり、本発明は、吸気弁のみならず排気弁にも適用可能である。

【００７９】以下、本発明の内燃機関の制御装置の第三の実施形態について説明する。本実施形態の構成は図１～図７に示した第一の実施形態の構成とほぼ同様である。バルブリフト量変更装置９及び開閉タイミングシフト装置１１によって吸気弁２のバルブリフト量、作用角、開閉タイミング（位相）が変更せしめられると、それに伴って筒内ガス温度が変化する。筒内ガス温度が変化するにもかかわらず一律に所定のタイミングで点火が行われてしまうと、最適な点火時期からずれてしまい、内燃機関を適切に制御することができない。従って、最適なタイミングで点火を行い、内燃機関を適切に制御するためには、吸気弁２のバルブリフト量、作用角、開閉タイミング（位相）の変更に伴って変化する筒内ガス温度を正確に算出することが必要になる。

【００８０】図２３は本実施形態における点火時期算出方法を示したフローチャートである。このルーチンは所定時間間隔で実行される。図２３に示すように、このルーチンが開始されると、まずステップ３００において機関始動時であるか否かが判断される。ＹＥＳのときには、燃料増量が行われる機関始動時には筒内ガス温度を正確に算出し、それに基づいて点火時期を決定する必要がないと判断し、このルーチンを終了する。一方、ＮＯのときにはステップ３０１に進む。ステップ３０１では、吸気弁２のバルブリフト量ＬＴ、作用角ＶＡ、開閉タイミングＶＴ、吸気管内の圧力ＰＭ、機関回転数ＮＥに基づいて圧縮上死点時筒内ガス温度標準状態ＴＣＹＬｂが算出される。

【００８１】図２４は圧縮上死点時筒内ガス温度標準状態ＴＣＹＬｂとバルブリフト量ＬＴと開閉タイミング（位相）ＶＴとの関係を示した図である。図２４に示すように、ステップ３０１において算出される圧縮上死点時筒内ガス温度標準状態ＴＣＹＬｂは、吸気下死点以降に吸気弁２が全閉する場合、バルブリフト量ＬＴが大きくなるに従って高くなり、また、開閉タイミング（位相）ＶＴが進角されるに従って高くなる。図２５に示すように、ステップ３０１において算出される圧縮上死点時筒内ガス温度標準状態ＴＣＹＬｂは、吸気下死点以前に吸気弁２が全閉する場合、バルブリフト量ＬＴが大きくなるに従って高くなり、また、開閉タイミング（位相）ＶＴが遅角されるに従って高くなる。図２６は圧縮上死点時筒内ガス温度標準状態ＴＣＹＬｂとバルブリフト量ＬＴと作用角ＶＡとの関係を示した図である。図２６に示すように、ステップ３０１において算出される圧縮上死点時筒内ガス温度標準状態ＴＣＹＬｂは、吸気下死点以降に吸気弁２が全閉する場合、作用角ＶＡが大きくなるに従って高くなる。図２７は圧縮上死点時筒内ガス温度標準状態ＴＣＹＬｂとバルブリフト量ＬＴと作用角ＶＡとの関係を示した図である。図２７に示すように、ステップ３０１において算出される圧縮上死点時筒内ガス温度標準状態ＴＣＹＬｂは、吸気下死点以前に吸気弁２が全閉する場合、作用角ＶＡが小さくなるに従って高くなる。

【００８２】図２８は圧縮上死点時筒内ガス温度標準状態ＴＣＹＬｂと吸気管内の圧力ＰＭとの関係を示した図である。図２８に示すように、ステップ３０１において算出される圧縮上死点時筒内ガス温度標準状態ＴＣＹＬｂは、吸気管内の圧力ＰＭが高くなるに従って高くなる。図２９に示すように、ステップ３０１において算出される圧縮上死点時筒内ガス温度標準状態ＴＣＹＬｂは、機関回転数ＮＥが中速のときにピークとなる。

【００８３】図２３の説明に戻り、次いでステップ３０２では、シリンダ壁温Ｔｗａｌｌに基づく受熱補正値ＫＴＷＡＬＬが算出される。シリンダ壁温Ｔｗａｌｌは下記の式に基づいて推定される。

$$Twall=(K1\times Ga(i)-Tw(i)-Twall(i-1))\times K2+Twall(i)$$

【００８４】ここで、Ｋ１は燃焼補正係数、Ｋ２は応答係数、Ｇａはエアフローメータ１９の出力値に基づいて算出された吸入空気量、Ｔｗは機関冷却水温、ｉは図２３に示すルーチンが今回実行されているときの値、ｉ－

１は図２３に示すルーチンが前回実行されたときの値である。燃焼補正係数Ｋ１は、燃料噴射弁１５から噴射された燃料が燃焼している時には正の値になり、燃料カットが行われ、燃料が燃焼していないモータリング時には負の値になる。図３０は、受熱補正値ＫＴＷＡＬＬと、シリンダ壁温Ｔｗａｌｌと圧縮上死点時筒内ガス温度標準状態ＴＣＹＬｂとの差分と、機関回転数ＮＥとの関係を示した図である。図３０に示すように、受熱補正値ＫＴＷＡＬＬは、圧縮上死点時筒内ガス温度標準状態ＴＣＹＬｂよりもシリンダ壁温Ｔｗａｌｌが高くなるに従って大きくなり、また、機関回転数ＮＥが低くなるに従って大きくなる。

【００８５】図２３の説明に戻り、次いでステップ３０３では、気筒内に吸入される吸入空気温に基づく吸入空気温変化補正値ＫＴＩＮが算出される。図３１は吸入空気温変化補正値ＫＴＩＮと機関冷却水温Ｔｗと吸入空気量Ｇａとの関係を示した図である。図３１に示すように、吸入空気温変化補正値ＫＴＩＮは、機関冷却水温Ｔｗが高くなるに従って大きくなり、また、吸入空気量Ｇａが少なくなるに従って大きくなる。

【００８６】図２３の説明に戻り、次いでステップ３０４では、気筒内における内部ＥＧＲガス割合に基づく内部ＥＧＲガス温度変化補正値ＫＴＥＧＲが算出される。図３２は内部ＥＧＲガス温度変化補正値ＫＴＥＧＲと内部ＥＧＲガス割合との関係を示した図である。図３２に示すように、内部ＥＧＲガス温度変化補正値ＫＴＥＧＲは内部ＥＧＲガス割合が高くなるに従って大きくなる。本実施形態の変形例では、内部ＥＧＲガス量に基づいて内部ＥＧＲガス温度変化補正値ＫＴＥＧＲを算出することも可能である。その場合、内部ＥＧＲガス温度変化補正値ＫＴＥＧＲは内部ＥＧＲガス量が多くなるに従って大きくなる。本実施形態の他の変形例では、前回の点火時期と前回の１回転当たりの燃焼ガス量とに基づいて内部ＥＧＲガス温度変化補正値ＫＴＥＧＲを算出することも可能である。図３３は内部ＥＧＲガス温度変化補正値ＫＴＥＧＲと前回の点火時期と前回の１回転当たりの燃焼ガス量との関係を示した図である。図３３に示すように、内部ＥＧＲガス温度変化補正値ＫＴＥＧＲは、前回の点火時期が遅角されるに従って大きくなり、また、前回の１回転当たりの燃焼ガス量が多くなるに従って大きくなる。本実施形態の更に他の変形例では、前回の空燃比に基づいて内部ＥＧＲガス温度変化補正値ＫＴＥＧＲを算出することも可能である。図３４は内部ＥＧＲガス温度変化補正値ＫＴＥＧＲと前回の空燃比との関係を示した図である。図３４に示すように、内部ＥＧＲガス温度変化補正値ＫＴＥＧＲは、ストイキよりもややリッチの空燃比においてピークとなり、それよりもリッチになってもリーンになっても小さくなる。

【００８７】図２３の説明に戻り、次いでステップ３０５では、ステップ３０１において算出された圧縮上死点時筒内ガス温度標準状態ＴＣＹＬｂと、ステップ３０２において算出された受熱補正値ＫＴＷＡＬＬと、ステップ３０３において算出された吸入空気温変化補正値ＫＴＩＮと、ステップ３０４において算出された内部ＥＧＲガス温度変化補正値ＫＴＥＧＲとに基づいて圧縮上死点時筒内ガス温度ＴＣＹＬが算出される（ＴＣＹＬ←ＴＣＹＬｂ×ＫＴＷＡＬＬ×ＫＴＩＮ×ＫＴＥＧＲ）。次いでステップ３０６では、圧縮上死点時筒内ガス温度ＴＣＹＬと１回転当たりの吸入空気量ＧＮと機関回転数ＮＥとに基づいて点火時期ＳＡが算出される。図３５は点火時期ＳＡと圧縮上死点時筒内ガス温度ＴＣＹＬと１回転当たりの吸入空気量ＧＮとの関係を示した図である。図３５に示すように、ステップ３０６において算出される点火時期ＳＡは、圧縮上死点時筒内ガス温度ＴＣＹＬが高くなるに従って遅角せしめられ、１回転当たりの吸入空気量ＧＮが多くなるに従って遅角せしめられる。また図１６に示したように、ステップ３０６において算出される点火時期ＳＡは、機関回転数ＮＥが高くなるに従って進角せしめられる。

【００８８】上述したように本実施形態では、図２３のステップ３０１及びステップ３０５において、筒内ガス温度（圧縮上死点時筒内ガス温度ＴＣＹＬ）が、可変動弁機構としてのバルブリフト量変更装置９によってバルブリフト量ＬＴが変更されるのに伴って変更せしめられる吸気弁２の開口面積に基づいて算出され、その筒内ガス温度に基づいて内燃機関が制御される。従って本実施形態によれば、特開平４－８１５７４号公報に記載された内燃機関の制御装置のようにシリンダ壁温に基づいて内燃機関が制御される場合よりも内燃機関を適切に制御することができる。更に、吸気弁２の開口面積が変更せしめられる場合であっても内燃機関を適切に制御することができる。詳細には、図２４及び図２５に示したように吸気弁２の開口面積が増加するに従って、吸気弁の開口面積に基づいて算出される筒内ガス温度が高くなり、図３５に示したように筒内ガス温度が高くなるに従って点火時期ＳＡが遅角せしめられるように内燃機関が制御される。

【００８９】更に本実施形態では、図２３のステップ３０１及びステップ３０５において、筒内ガス温度（圧縮上死点時筒内ガス温度ＴＣＹＬ）が、可変動弁機構としてのバルブリフト量変更装置９によって変更せしめられる吸気弁２の作用角ＶＡに基づいて算出され、その筒内ガス温度に基づいて内燃機関が制御される。従って本実施形態によれば、特開平４－８１５７４号公報に記載された内燃機関の制御装置のようにシリンダ壁温に基づいて内燃機関が制御される場合よりも内燃機関を適切に制御することができる。更に、吸気弁２の作用角ＶＡが変更せしめられる場合であっても内燃機関を適切に制御することができる。詳細には、図２６に示したように吸気下死点以降に吸気弁２が全閉する場合、吸気弁２の作用

角ＶＡが増加するに従って、吸気弁２の作用角ＶＡに基づいて算出される筒内ガス温度が高くなり、図３５に示したように筒内ガス温度が高くなるに従って点火時期ＳＡが遅角せしめられるように内燃機関が制御される。また、図２７に示したように吸気下死点以前に吸気弁２が全閉する場合、吸気弁２の作用角ＶＡが減少するに従って、吸気弁２の作用角ＶＡに基づいて算出される筒内ガス温度が高くなり、図３５に示したように筒内ガス温度が高くなるに従って点火時期ＳＡが遅角せしめられるように内燃機関が制御される。

【００９０】また本実施形態では、図２３のステップ３０１及びステップ３０５において、筒内ガス温度（圧縮上死点時筒内ガス温度ＴＣＹＬ）が、可変動弁機構としてのバルブリフト量変更装置９によって変更せしめられる吸気弁２の開口面積及び作用角ＶＡの両方に基づいて算出され、その筒内ガス温度に基づいて内燃機関が制御される。従って本実施形態によれば、吸気弁２の作用角ＶＡに基づくことなく吸気弁２の開口面積のみに基づいて筒内ガス温度が算出される場合や、吸気弁２の開口面積に基づくことなく吸気弁２の作用角ＶＡのみに基づいて筒内ガス温度が算出される場合よりも、筒内ガス温度を正確に算出し、内燃機関を適切に制御することができる。

【００９１】また本実施形態では、図２３のステップ３０１及びステップ３０５において、筒内ガス温度（圧縮上死点時筒内ガス温度ＴＣＹＬ）が、吸気弁２の開閉タイミング（位相）ＶＴ、吸気管内の圧力ＰＭ、及び機関回転数ＮＥに基づいて算出され、その筒内ガス温度に基づいて内燃機関が制御される。従って本実施形態によれば、吸気弁２の開閉タイミング（位相）ＶＴ、吸気管内の圧力ＰＭ、及び機関回転数ＮＥに基づいて筒内ガス温度が算出されない場合よりも筒内ガス温度を正確に算出し、内燃機関を適切に制御することができる。

【００９２】また本実施形態では、図２３のステップ３０２においてシリンダ壁温Ｔｗａｌｌ及び機関回転数ＮＥに基づいて筒内ガス温度が補正され、ステップ３０３において吸入空気量Ｇａに基づいて筒内ガス温度が補正され、更に、ステップ３０４において内部ＥＧＲガス量（内部ＥＧＲガス割合）、つまり、その影響を受けて変化する内部ＥＧＲガス温度に基づいて筒内ガス温度が補正される。従って本実施形態によれば、それらに基づいて筒内ガス温度が補正されない場合よりも内燃機関を適切に制御することができる。

【００９３】尚、本実施形態では吸気弁の開口面積等に基づいて筒内ガス温度を算出し、その筒内ガス温度に基づいて内燃機関が制御されているが、他の実施形態では、排気弁の開口面積等に基づいて筒内ガス温度を算出し、その筒内ガス温度に基づいて内燃機関を制御することも可能である。つまり、本発明は、吸気弁のみならず排気弁にも適用可能である。

【００９４】以下、本発明の内燃機関の制御装置の第四の実施形態について説明する。本実施形態の構成は図１～図７に示した第一の実施形態の構成とほぼ同様である。バルブリフト量変更装置９及び開閉タイミングシフト装置１１によって吸気弁２のバルブリフト量、作用角、開閉タイミング（位相）が変更せしめられると、それに伴って気筒内における内部ＥＧＲガス割合が変化する。内部ＥＧＲガス割合が変化するにもかかわらず一律に所定のタイミングで点火が行われてしまうと、最適な点火時期からずれてしまい、内燃機関を適切に制御することができない。従って、最適なタイミングで点火を行い、内燃機関を適切に制御するためには、吸気弁２のバルブリフト量、作用角、開閉タイミング（位相）の変更に伴って変化する内部ＥＧＲガス割合を正確に算出することが必要になる。

【００９５】図３６は本実施形態における点火時期算出方法を示したフローチャートである。このルーチンは所定時間間隔で実行される。図３６に示すように、このルーチンが開始されると、まずステップ４００において機関始動時であるか否かが判断される。ＹＥＳのときには、燃料増量が行われる機関始動時には内部ＥＧＲガス割合を正確に算出し、それに基づいて点火時期を決定する必要がないと判断し、このルーチンを終了する。一方、ＮＯのときにはステップ４０１に進む。ステップ４０１では、吸気弁２のバルブリフト量ＬＴ、作用角ＶＡ、開閉タイミングＶＴ、吸気管内の圧力ＰＭ、機関回転数ＮＥに基づいて内部ＥＧＲガス割合標準状態定常値ＫＥＧＲｂが算出される。

【００９６】図３７は内部ＥＧＲガス割合標準状態定常値ＫＥＧＲｂとバルブリフト量ＬＴと開閉タイミング（位相）ＶＴとの関係を示した図である。図３７に示すように、ステップ４０１において算出される内部ＥＧＲガス割合標準状態定常値ＫＥＧＲｂは、バルブリフト量ＬＴが大きくなるに従って大きくなり、また、開閉タイミング（位相）ＶＴが進角されるに従って大きくなる。図３８は内部ＥＧＲガス割合標準状態定常値ＫＥＧＲｂと作用角ＶＡと開閉タイミング（位相）ＶＴとの関係を示した図である。図３８に示すように、ステップ４０１において算出される内部ＥＧＲガス割合標準状態定常値ＫＥＧＲｂは、作用角ＶＡが大きくなるに従って大きくなる。

【００９７】図３９は内部ＥＧＲガス割合標準状態定常値ＫＥＧＲｂと吸気管内の圧力ＰＭとの関係を示した図である。図３９に示すように、ステップ４０１において算出される内部ＥＧＲガス割合標準状態定常値ＫＥＧＲｂは、吸気管内の圧力ＰＭが高くなるに従って小さくなる。図４０に示すように、ステップ４０１において算出される内部ＥＧＲガス割合標準状態定常値ＫＥＧＲｂは、機関回転数ＮＥが高くなるに従って小さくなる。

【００９８】図３６の説明に戻り、次いでステップ４０

２では、内部ＥＧＲガス割合標準状態定常値ＫＥＧＲｂと大気圧補正係数ＫＰＡとに基づいて内部ＥＧＲガス割合定常値ＫＥＧＲＳＴが算出される（ＫＥＧＲＳＴ←ＫＥＧＲｂ×ＫＰＡ）。つまり、内部ＥＧＲガス割合が大気圧を考慮して補正される。図４１は大気圧補正係数ＫＰＡと大気圧との関係を示した図である。図４１に示すように、大気圧補正係数ＫＰＡは大気圧が高くなるに従って大きくなる。すなわち、内部ＥＧＲガス割合は大気圧が高くなるほど高くなる。本実施形態の変形例では、図４１に示したように大気圧に基づいて補正係数ＫＰＡを算出する代わりに、背圧に基づいて補正係数を算出し、その補正係数に基づいて内部ＥＧＲガス割合を補正することも可能である。図４２は背圧と機関回転数ＮＥと１回転当たりの吸入空気量ＧＮとの関係を示した図である。図４２に示すように、背圧は、機関回転数ＮＥが高くなるに従って高くなり、また、１回転当たりの吸入空気量ＧＮが多くなるに従って高くなる。図４３は内部ＥＧＲガス割合を補正するための背圧補正係数と背圧との関係を示した図である。図４３に示すように、背圧補正係数は背圧が高くなるに従って大きくなる。すなわち、内部ＥＧＲガス割合は背圧が高くなるほど高くなる。

【００９９】また本実施形態の変形例では、図３６のステップ４０２の次の不図示のステップにおいて、吸気管内に吹き返された後に再び気筒内に吸入される既燃ガスの量（以下、「吹き返しガス量」という）に基づいて内部ＥＧＲガス割合定常値ＫＥＧＲＳＴを補正することも可能である。図４４は吹き返しガス量と吸気弁２の平均的な開口面積（バルブオーバラップ期間中における吸気弁の開口面積の平均値）と吸気弁２の平均的な前後差圧（バルブオーバラップ期間中における筒内圧と吸気管内の圧力との差分の平均値）との関係を示した図である。図４４に示すように、吹き返しガス量は、吸気弁２の開口面積が大きくなるに従って多くなり、また、吸気弁の前後差圧が大きくなるに従って、つまり、筒内圧が吸気管内の圧力よりも高くなるに従って多くなる。図４５は内部ＥＧＲガス割合定常値ＫＥＧＲＳＴと吹き返しガス量との関係を示した図である。図４５に示すように、内部ＥＧＲガス割合定常値ＫＥＧＲＳＴは吹き返しガス量が多くなるに従って大きくなる。つまり、内部ＥＧＲガス割合定常値ＫＥＧＲＳＴは、吸気弁２の開口面積が大きくなるに従って大きくなり、また、筒内圧が吸気管内の圧力よりも高くなるに従って大きくなる。この変形例によれば、可変動弁機構によって変更せしめられるバルブオーバラップ期間中の吸気弁２の開口面積と、バルブオーバラップ期間中における吸気弁２の下流側の圧力（筒内圧）及び上流側の圧力（吸気管内の圧力）とに基づいて内部ＥＧＲガス割合が算出され、その内部ＥＧＲガス割合に基づいて内燃機関が制御されるため、可変動弁機構によって変更せしめられる吸気弁２の開口面積のみに基づいて内部ＥＧＲガス割合が算出され、バルブオーバラップ期間中における吸気弁の下流側の圧力及び上流側の圧力に基づいて内部ＥＧＲガス割合が算出されない場合よりも、内部ＥＧＲガス割合を正確に算出し、内燃機関を適切に制御することができる。

【０１００】また、この変形例の更なる変形例では、バルブオーバラップ期間中における吸気弁の開口面積の平均値及びバルブオーバラップ期間中における筒内圧と吸気管内の圧力との差分の平均値の代わりに、バルブオーバラップ期間中における所定時間毎の開口面積及びバルブオーバラップ期間中における所定時間毎の筒内圧（吸気弁２の下流側の圧力）と吸気管内の圧力（吸気弁２の上流側の圧力）との差分に基づいて瞬時内部ＥＧＲガス割合を算出し、その瞬時内部ＥＧＲガス割合を積算することにより得られた内部ＥＧＲガス割合に基づいて内燃機関を制御することも可能である。この変形例によれば、バルブオーバラップ期間中における吸気弁２の開口面積やバルブオーバラップ期間中における吸気弁の上流側の圧力及び下流側の圧力の変化が大きい場合であっても、内部ＥＧＲガス割合を正確に算出し、内燃機関を適切に制御することができる。

【０１０１】図３６の説明に戻り、次いでステップ４０３では、前回の内部ＥＧＲガス割合ＫＥＧＲＯと吸気管内の圧力ＰＭとに基づいて前回からの変化割合ＫＥＧＲＳＭが算出される。図４６は前回の内部ＥＧＲガス割合の影響度（＝１－前回からの変化割合ＫＥＧＲＳＭ）と前回の内部ＥＧＲガス割合ＫＥＧＲＯと吸気管内の圧力ＰＭとの関係を示した図である。図４６に示すように、前回の内部ＥＧＲガス割合の影響度は、前回の内部ＥＧＲガス割合ＫＥＧＲＯが小さくなるに従って小さくなり、また、吸気管内の圧力ＰＭが高くなるに従って小さくなる。つまり、前回からの変化割合ＫＥＧＲＳＭは、前回の内部ＥＧＲガス割合ＫＥＧＲＯが小さくなるに従って大きくなり、また、吸気管内の圧力ＰＭが高くなるに従って大きくなる。

【０１０２】図３６の説明に戻り、次いでステップ４０４では、内部ＥＧＲガス割合定常値ＫＥＧＲＳＴと前回の内部ＥＧＲガス割合ＫＥＧＲＯ（＝前回このルーチンが実行されたときにステップ４０４において算出された内部ＥＧＲガス割合ＫＥＧＲ）と前回からの変化割合ＫＥＧＲＳＭとに基づいて内部ＥＧＲガス割合ＫＥＧＲが算出される（ＫＥＧＲ←（ＫＥＧＲＳＴ－ＫＥＧＲＯ）×ＫＥＧＲＳＭ＋ＫＥＧＲＯ）。次いでステップ４０５では、内部ＥＧＲガス割合ＫＥＧＲと１回転当たりの吸入空気量ＧＮと機関回転数ＮＥとに基づいて点火時期ＳＡが算出される。図４７に示すように、ステップ４０５において算出される点火時期ＳＡは、内部ＥＧＲガス割合ＫＥＧＲが高くなるに従って進角せしめられ、１回転当たりの吸入空気量ＧＮが少なくなるに従って進角せしめられる。図４８は点火時期ＳＡと機関回転数ＮＥとの

関係を示した図である。図４８に示したように、ステップ４０５において算出される点火時期ＳＡは、機関回転数ＮＥが高くなるに従って進角せしめられる。

【０１０３】上述したように本実施形態では、図３６のステップ４０１及びステップ４０４において、内部ＥＧＲガス割合が、可変動弁機構としてのバルブリフト量変更装置９によってバルブリフト量ＬＴが変更されるのに伴って変更せしめられる吸気弁２の開口面積に基づいて算出され、その内部ＥＧＲガス割合に基づいて内燃機関が制御される。従って本実施形態によれば、特開平９－２０９８９５号公報に記載された内燃機関の制御装置のように可変動弁機構による吸気弁２の開口面積の変更を考慮することなく内部ＥＧＲガス割合が算出される場合よりも、内部ＥＧＲガス割合を正確に算出し、内燃機関を適切に制御することができる。つまり、吸気弁２の開口面積が変更せしめられる場合であっても内部ＥＧＲガス割合を正確に算出し、内燃機関を適切に制御することができる。詳細には、図３７に示したように吸気弁２の開口面積が増加するに従って、吸気弁の開口面積に基づいて算出される内部ＥＧＲガス割合が高くなり、図４７に示したように内部ＥＧＲガス割合が高くなるに従って点火時期ＳＡが進角せしめられるように内燃機関が制御される。

【０１０４】更に本実施形態では、図３６のステップ４０１及びステップ４０４において、内部ＥＧＲガス割合が、可変動弁機構としてのバルブリフト量変更装置９によって変更せしめられる吸気弁２の作用角ＶＡに基づいて算出され、その内部ＥＧＲガス割合に基づいて内燃機関が制御される。従って本実施形態によれば、特開平９－２０９８９５号公報に記載された内燃機関の制御装置のように可変動弁機構による吸気弁２の作用角ＶＡの変更を考慮することなく内部ＥＧＲガス割合が算出される場合よりも、内部ＥＧＲガス割合を正確に算出し、内燃機関を適切に制御することができる。つまり、吸気弁２の作用角ＶＡが変更せしめられる場合であっても内部ＥＧＲガス割合を正確に算出し、内燃機関を適切に制御することができる。詳細には、図３８に示したように吸気弁２の作用角ＶＡが増加するに従って、吸気弁の作用角に基づいて算出される内部ＥＧＲガス割合が高くなり、図４７に示したように内部ＥＧＲガス割合が高くなるに従って点火時期ＳＡが進角せしめられるように内燃機関が制御される。

【０１０５】また本実施形態では、図３６のステップ４０１及びステップ４０４において、内部ＥＧＲガス割合が、可変動弁機構としてのバルブリフト量変更装置９によって変更せしめられる吸気弁２の開口面積及び作用角ＶＡの両方に基づいて算出され、その内部ＥＧＲガス割合に基づいて内燃機関が制御される。従って本実施形態によれば、吸気弁２の作用角ＶＡに基づくことなく吸気弁２の開口面積のみに基づいて内部ＥＧＲガス割合が算出される場合や、吸気弁２の開口面積に基づくことなく吸気弁２の作用角ＶＡのみに基づいて内部ＥＧＲガス割合が算出される場合よりも、内部ＥＧＲガス割合を正確に算出し、内燃機関を適切に制御することができる。

【０１０６】また本実施形態では、図３６のステップ４０１及びステップ４０４において、内部ＥＧＲガス割合が、吸気弁２の開閉タイミング（位相）ＶＴ、吸気管内の圧力ＰＭ、及び機関回転数ＮＥに基づいて算出され、その内部ＥＧＲガス割合に基づいて内燃機関が制御される。従って本実施形態によれば、吸気弁２の開閉タイミング（位相）ＶＴ、吸気管内の圧力ＰＭ、及び機関回転数ＮＥに基づいて内部ＥＧＲガス割合が算出されない場合よりも内部ＥＧＲガス割合を正確に算出し、内燃機関を適切に制御することができる。

【０１０７】また本実施形態では、図３６のステップ４０２において大気圧に基づいて内部ＥＧＲガス割合が補正され、ステップ４０２の変形例において排気管内の圧力、つまり、背圧に基づいて内部ＥＧＲガス割合が補正され、更に、ステップ４０４において前回のルーチンで算出した内部ＥＧＲガス割合ＫＥＧＲＯに基づいて内部ＥＧＲガス割合が補正される。従って本実施形態によれば、それらに基づいて内部ＥＧＲガス割合が補正されない場合よりも内燃機関を適切に制御することができる。

【０１０８】上述した実施形態及びその変形例では、内部ＥＧＲガス割合が算出され、それに基づいて内燃機関が制御されているが、その代わりに、上述した方法と同様の方法によって内部ＥＧＲガス量を算出し、それに基づいて内燃機関を制御することも可能である。すなわち、上述した図における曲線の傾きの傾向は、内部ＥＧＲガス割合を用いる場合と内部ＥＧＲガス量を用いる場合とで同様になる。

【０１０９】尚、本実施形態及びその変形例では吸気弁の開口面積等に基づいて内部ＥＧＲガス割合又は量を算出し、その内部ＥＧＲガス割合又は量に基づいて内燃機関が制御されているが、他の実施形態では、排気弁の開口面積等に基づいて内部ＥＧＲガス割合又は量を算出し、その内部ＥＧＲガス割合又は量に基づいて内燃機関を制御することも可能である。つまり、本発明は、吸気弁のみならず排気弁にも適用可能である。

【０１１０】以下、本発明の内燃機関の制御装置の第五の実施形態について説明する。本実施形態の構成は図１～図７に示した第一の実施形態の構成とほぼ同様である。バルブリフト量変更装置９及び開閉タイミングシフト装置１１によって吸気弁２のバルブリフト量、作用角、開閉タイミング（位相）が変更せしめられると、それに伴って筒内乱れの程度が変化する。筒内乱れの程度が変化するにもかかわらず一律に所定のタイミングで点火が行われてしまうと、最適な点火時期からずれてしまい、内燃機関を適切に制御することができない。従って、最適なタイミングで点火を行い、内燃機関を適切に

制御するためには、吸気弁２のバルブリフト量、作用角、開閉タイミング（位相）の変更に伴って変化する筒内乱れの程度を正確に算出することが必要になる。

【０１１１】図４９は本実施形態における点火時期算出方法を示したフローチャートである。このルーチンは所定時間間隔で実行される。図４９に示すように、このルーチンが開始されると、まずステップ５００において機関始動時であるか否かが判断される。ＹＥＳのときには、燃料増量が行われる機関始動時には筒内乱れを正確に算出し、それに基づいて点火時期を決定する必要がないと判断し、このルーチンを終了する。一方、ＮＯのときにはステップ５０１に進む。ステップ５０１では、吸気弁２のバルブリフト量ＬＴ、作用角ＶＡ、開閉タイミングＶＴ、吸気管内の圧力ＰＭ、機関回転数ＮＥに基づいて筒内乱れＣＹＬＴＲＢが算出される。

【０１１２】図５０は筒内乱れＣＹＬＴＲＢとバルブリフト量ＬＴと開閉タイミング（位相）ＶＴとの関係を示した図である。図５０に示すように、ステップ５０１において算出される筒内乱れＣＹＬＴＲＢは、バルブリフト量ＬＴが小さくなるに従って大きくなり、また、開閉タイミング（位相、吸気弁２の開弁時期）ＶＴが遅角されるに従って大きくなる。図５１は筒内乱れＣＹＬＴＲＢと作用角ＶＡと開閉タイミング（位相）ＶＴとの関係を示した図である。図５１に示すように、ステップ５０１において算出される筒内乱れＣＹＬＴＲＢは、作用角ＶＡが小さくなるに従って大きくなる。

【０１１３】図５２は筒内乱れＣＹＬＴＲＢと吸気管内の圧力ＰＭとの関係を示した図である。図５２に示すように、ステップ５０１において算出される筒内乱れＣＹＬＴＲＢは、吸気管内の圧力ＰＭが高くなるに従って小さくなる。図５３は筒内乱れＣＹＬＴＲＢと機関回転数ＮＥとの関係を示した図である。図５３に示すように、ステップ５０１において算出される筒内乱れＣＹＬＴＲＢは、機関回転数ＮＥが高くなるに従って大きくなる。

【０１１４】図４９の説明に戻り、次いでステップ５０２では、筒内乱れＣＹＬＴＲＢと１回転当たりの吸入空気量ＧＮと機関回転数ＮＥとに基づいて点火時期ＳＡが算出される。図５４は点火時期ＳＡと筒内乱れＣＹＬＴＲＢと１回転当たりの吸入空気量ＧＮとの関係を示した図である。図５４に示すように、ステップ５０２において算出される点火時期ＳＡは、筒内乱れＣＹＬＴＲＢが大きくなるに従って遅角せしめられ、１回転当たりの吸入空気量ＧＮが多くなるに従って遅角せしめられる。図５５は点火時期ＳＡと機関回転数ＮＥとの関係を示した図である。図５５に示したように、ステップ５０２において算出される点火時期ＳＡは、機関回転数ＮＥが高くなるに従って進角せしめられる。

【０１１５】上述したように本実施形態では、図４９のステップ５０１において、筒内乱れＣＹＬＴＲＢが、可変動弁機構としてのバルブリフト量変更装置９によってバルブリフト量ＬＴが変更されるのに伴って変更せしめられる吸気弁２の開口面積に基づいて算出され、その筒内乱れＣＹＬＴＲＢに基づいて内燃機関が制御される。従って本実施形態によれば、特開２０００－７３８００号公報に記載された内燃機関の制御装置のように可変動弁機構による吸気弁２の開口面積の変更を考慮することなく筒内乱れＣＹＬＴＲＢが算出される場合よりも、筒内乱れＣＹＬＴＲＢを正確に算出し、内燃機関を適切に制御することができる。つまり、吸気弁２の開口面積が変更せしめられる場合であっても筒内乱れＣＹＬＴＲＢを正確に算出し、内燃機関を適切に制御することができる。詳細には、図５０に示したように吸気弁２の開口面積が減少するに従って、吸気弁の開口面積に基づいて算出される筒内乱れＣＹＬＴＲＢが大きくなり、図５４に示したように筒内乱れＣＹＬＴＲＢが大きくなるに従って点火時期ＳＡが遅角せしめられるように内燃機関が制御される。

【０１１６】更に本実施形態では、図４９のステップ５０１において、筒内乱れＣＹＬＴＲＢが、吸気弁２の作用角ＶＡ、吸気弁２の開閉タイミング（位相）ＶＴ、吸気管内の圧力ＰＭ、及び機関回転数ＮＥに基づいて算出され、その筒内乱れＣＹＬＴＲＢに基づいて内燃機関が制御される。従って本実施形態によれば、吸気弁２の作用角ＶＡ、吸気弁２の開閉タイミング（位相）ＶＴ、吸気管内の圧力ＰＭ、及び機関回転数ＮＥに基づいて筒内乱れＣＹＬＴＲＢが算出されない場合よりも筒内乱れＣＹＬＴＲＢを正確に算出し、内燃機関を適切に制御することができる。

【０１１７】尚、本実施形態及びその変形例では吸気弁の開口面積等に基づいて筒内乱れを算出し、その筒内乱れに基づいて内燃機関が制御されているが、他の実施形態では、排気弁の開口面積等に基づいて筒内乱れを算出し、その筒内乱れに基づいて内燃機関を制御することも可能である。つまり、本発明は、吸気弁のみならず排気弁にも適用可能である。

【０１１８】以下、本発明の内燃機関の制御装置の第六の実施形態について説明する。本実施形態の構成は、後述する点を除いて図１～図７に示した第一の実施形態の構成とほぼ同様である。また、後述する本実施形態の制御ルーチンは、上述した実施形態のいずれかの制御ルーチンと組み合わせて実行される。上述した実施形態においては、図３に示したようにカムノーズ高さが連続的に変化しているカムが設けられているが、本実施形態では、代わりに、カムノーズ高さが比較的高い高速カムＨと、カムノーズ高さが比較的低い低速カムＬと、カムノーズ高さがそれらの中間となる中速カムＭとが設けられている。

【０１１９】図５６は本実施形態におけるカム制御方法を示したフローチャートである。このルーチンは所定時間間隔で実行される。図５６に示すように、このルーチ

ンが開始されると、まずステップ６００において、不図示のアクセル開度センサの出力値に基づいて算出されたアクセル開度が読み込まれる。次いでステップ６０１では、機関回転数センサ１７の出力値に基づいて算出された機関回転数が読み込まれる。次いでステップ６０２では、アクセル開度と機関回転数と図５７に示す関係とに基づいてカムが選択される。図５７はアクセル開度と機関回転数と選択すべきカムとの関係を示した図である。図５７に示すように、アクセル開度が小さくかつ機関回転数が低いときには低速カムＬが選択され、アクセル開度が大きくなるに従って選択されるカムのカムノーズ高さが高くなり、また、機関回転数が高くなるに従って選択されるカムのカムノーズ高さが高くなる。

【０１２０】次いでステップ６０３では、カム切換えタイミングであるか否かが判断される。ＹＥＳのときにはステップ６０４に進み、ＮＯのときにはこのルーチンを終了する。ステップ６０４では、選択されたカムへの切換えが行われる。次いでステップ６０５では、機関回転数と、冷却水温センサ２０の出力値に基づいて算出された冷却水温と、図５８に示す関係とに基づいてカム切換え遅れが推定される。図５８はカム切換え遅れと機関回転数と冷却水温との関係を示した図である。図５８に示すように、カム切換え遅れは、機関回転数が高くなるに従って小さくなり、また、冷却水温が高くなるに従って小さくなる。

【０１２１】本実施形態の変形例では、冷却水温等に基づいてカム切換え遅れを推定する代わりに、カムを作動する作動油の油圧に基づいてカム切換え遅れを推定することも可能である。図５９はカム切換え遅れと油圧との関係を示した図である。図５９に示すように、カム切換え遅れは、油圧が高くなるに従って小さくなると推定される。

【０１２２】本実施形態の他の変形例では、カムの切換え以前に予め運転条件又は油圧に基づいてカム切換え遅れを推定し、その遅れを考慮してカム切換え時期が決定される。図６０はカムを切換えるための指示が出される時期と実際にカムが切換わる時期との関係等を示した図である。図６０に示すように、カム切換え遅れ（＝時間ｔ１－時間ｔ０）が推定され、実際にカムを時間ｔ１に切換えようとする場合には、カムを切換えるための指示は時間ｔ０に出されることになる。

【０１２３】図６１は本実施形態における燃料噴射量算出方法を示したフローチャートである。このルーチンは所定時間間隔で実行される。図６１に示すように、このルーチンが開始されると、まずステップ７００において、エアフローメータ１９の出力値が読み込まれる。次いでステップ７０１では、機関回転数センサ１７の出力値に基づいて算出された機関回転数が読み込まれる。次いでステップ７０２では、カム選択推定値が読み込まれる。つまり、図５６のステップ６０２において選択されるカムを示すフラグが読み込まれる。次いでステップ７０３では、上述した実施形態と同様の方法により１回転当たりの吸入空気量が算出される。次いでステップ７０４では、カムの種類と機関回転数と１回転当たりの吸入空気量と図６２に示す関係とに基づいて応答補正係数が算出される。図６２は応答補正係数とカムの種類と機関回転数と１回転当たりの吸入空気量ＧＮとの関係を示した図である。次いでステップ７０５では、１回転当たりの吸入空気量と図６３に示す関係とに基づいて燃料噴射量が算出される。図６３は燃料噴射量と１回転当たりの吸入空気量との関係を示した図である。

【０１２４】図６４は本実施形態における点火時期算出ルーチンを示したフローチャートである。このルーチンは所定時間間隔で実行される。図６４に示すように、このルーチンが開始されると、まずステップ８００において、１回転当たりの吸入空気量が読み込まれる。次いでステップ８０１では、機関回転数が読み込まれる。次いでステップ８０２ではカム選択推定値が読み込まれる。次いでステップ８０３では、カムの種類と機関回転数と１回転当たりの吸入空気量と図６５に示す関係とに基づいて点火時期が算出される。図６５は点火時期とカムの種類と機関回転数と１回転当たりの吸入空気量ＧＮとの関係を示した図である。

【０１２５】上述した実施形態の変形例では、カムによって駆動される吸排気弁の代わりに、必要に応じて電磁力や油圧によって駆動される吸排気弁を使用することも可能である。

【０１２６】

【発明の効果】請求項１に記載の発明によれば、特開平９－５３５０３号公報に記載された内燃機関の制御装置のように筒内圧センサによって筒内圧が検出される場合と異なり、燃焼圧ピーク時の筒内圧のみならず燃焼圧ピーク時以外の時点の筒内圧にも基づいて内燃機関を制御することができる。更に、吸排気弁の開口面積が変更せしめられる場合であっても内燃機関を適切に制御することができる。

【０１２７】請求項２に記載の発明によれば、特開平９－５３５０３号公報に記載された内燃機関の制御装置のように筒内圧センサによって筒内圧が検出される場合と異なり、燃焼圧ピーク時の筒内圧のみならず燃焼圧ピーク時以外の時点の筒内圧にも基づいて内燃機関を制御することができる。更に、吸排気弁の作用角が変更せしめられる場合であっても内燃機関を適切に制御することができる。

【０１２８】請求項３に記載の発明によれば、吸排気弁の作用角に基づくことなく吸排気弁の開口面積のみに基づいて筒内圧が算出される場合や、吸排気弁の開口面積に基づくことなく吸排気弁の作用角のみに基づいて筒内圧が算出される場合よりも、筒内圧を正確に算出し、内燃機関を適切に制御することができる。

【０１２９】請求項４に記載の発明によれば、吸気弁の位相、吸気管内の圧力、及び機関回転数に基づいて筒内圧が算出されない場合よりも筒内圧を正確に算出し、内燃機関を適切に制御することができる。

【０１３０】請求項５に記載の発明によれば、特開平４－８１５７４号公報に記載された内燃機関の制御装置のようにシリンダ壁温に基づいて内燃機関が制御される場合よりも内燃機関を適切に制御することができる。更に、吸排気弁の開口面積が変更せしめられる場合であっても内燃機関を適切に制御することができる。

【０１３１】請求項６に記載の発明によれば、特開平４－８１５７４号公報に記載された内燃機関の制御装置のようにシリンダ壁温に基づいて内燃機関が制御される場合よりも内燃機関を適切に制御することができる。更に、吸排気弁の作用角が変更せしめられる場合であっても内燃機関を適切に制御することができる。

【０１３２】請求項７に記載の発明によれば、吸排気弁の作用角に基づくことなく吸排気弁の開口面積のみに基づいて筒内ガス温度が算出される場合や、吸排気弁の開口面積に基づくことなく吸排気弁の作用角のみに基づいて筒内ガス温度が算出される場合よりも筒内ガス温度を正確に算出し、内燃機関を適切に制御することができる。

【０１３３】請求項８に記載の発明によれば、吸気弁の位相、吸気管内の圧力、及び機関回転数に基づいて筒内ガス温度が算出されない場合よりも筒内ガス温度を正確に算出し、内燃機関を適切に制御することができる。

【０１３４】請求項９に記載の発明によれば、それらのうちの少なくとも一つに基づいて筒内ガス温度が補正されない場合よりも内燃機関を適切に制御することができる。

【０１３５】請求項１０に記載の発明によれば、特開平９－２０９８９５号公報に記載された内燃機関の制御装置のように可変動弁機構による吸排気弁の開口面積の変更を考慮することなく内部ＥＧＲガス割合又は量が算出される場合よりも、内部ＥＧＲガス割合又は量を正確に算出し、内燃機関を適切に制御することができる。つまり、吸排気弁の開口面積が変更せしめられる場合であっても内部ＥＧＲガス量を正確に算出し、内燃機関を適切に制御することができる。

【０１３６】請求項１１に記載の発明によれば、特開平９－２０９８９５号公報に記載された内燃機関の制御装置のように可変動弁機構による吸排気弁の作用角の変更を考慮することなく内部ＥＧＲガス割合又は量が算出される場合よりも、内部ＥＧＲガス割合又は量を正確に算出し、内燃機関を適切に制御することができる。つまり、吸排気弁の作用角が変更せしめられる場合であっても内部ＥＧＲガス量を正確に算出し、内燃機関を適切に制御することができる。

【０１３７】請求項１２に記載の発明によれば、吸排気弁の作用角に基づくことなく吸排気弁の開口面積のみに基づいて内部ＥＧＲガス割合又は量が算出される場合や、吸排気弁の開口面積に基づくことなく吸排気弁の作用角のみに基づいて内部ＥＧＲガス割合又は量が算出される場合よりも、内部ＥＧＲガス割合又は量を正確に算出し、内燃機関を適切に制御することができる。

【０１３８】請求項１３に記載の発明によれば、吸気弁の位相、吸気管内の圧力、及び機関回転数に基づいて内部ＥＧＲガス割合又は量が算出されない場合よりも、内部ＥＧＲガス割合又は量を正確に算出し、内燃機関を適切に制御することができる。

【０１３９】請求項１４に記載の発明によれば、それらのうちの少なくとも一つに基づいて内部ＥＧＲガス割合又は量が補正されない場合よりも内燃機関を適切に制御することができる。

【０１４０】請求項１５に記載の発明によれば、可変動弁機構によって変更せしめられる吸気弁及び排気弁の少なくとも一方の開口面積のみに基づいて内部ＥＧＲガス割合又は量が算出され、バルブオーバラップ期間中における吸気弁の上流側の圧力及び下流側の圧力に基づいて内部ＥＧＲガス割合又は量が算出されない場合よりも、内部ＥＧＲガス割合又は量を正確に算出し、内燃機関を適切に制御することができる。

【０１４１】請求項１６に記載の発明によれば、吸排気弁の開口面積やバルブオーバラップ期間中における吸気弁の上流側の圧力及び下流側の圧力の変化が大きい場合であっても、内部ＥＧＲガス割合又は量を正確に算出し、内燃機関を適切に制御することができる。

【０１４２】請求項１７に記載の発明によれば、吸気弁の開口面積が減少するに従って筒内乱れの程度が減少すると推定され、その推定された筒内乱れの程度に基づいて内燃機関が制御される特開２０００－７３８００号公報に記載された内燃機関の制御装置と異なり、可変動弁機構によって吸気弁の開口面積が変更せしめられた場合であっても筒内乱れの程度を正確に推定し内燃機関を適切に制御することができる。

【０１４３】請求項１８に記載の発明によれば、吸気弁の位相、吸気管内の圧力、及び機関回転数に基づいて筒内乱れの程度が推定されない場合よりも、筒内乱れの程度を正確に推定し、内燃機関を適切に制御することができる。

【図面の簡単な説明】

【図１】本発明の内燃機関の制御装置の第一の実施形態の概略構成図である。

【図２】図１に示した内燃機関の制御装置の吸気系等の詳細図である。

【図３】図１に示した吸気弁用カム及びカムシャフトの詳細図である。

【図４】図１に示したバルブリフト量変更装置等の詳細図である。

【図５】バルブリフト量変更装置が作動されるのに伴って吸気弁のバルブリフト量が変化する様子を示した図である。

【図６】図１に示した開閉タイミングシフト装置等の詳細図である。

【図７】開閉タイミングシフト装置が作動されるのに伴って吸気弁の開閉タイミングがシフトする様子を示した図である。

【図８】第一の実施形態における点火時期算出方法を示したフローチャートである。

【図９】圧縮上死点時筒内圧力標準状態ＰＣＹＬｂとバルブリフト量ＬＴと吸気管内の圧力ＰＭとの関係を示した図である。

【図１０】圧縮上死点時筒内圧力標準状態ＰＣＹＬｂと作用角ＶＡと吸気管内の圧力ＰＭとの関係を示した図である。

【図１１】圧縮上死点時筒内圧力標準状態ＰＣＹＬｂと作用角ＶＡと吸気管内の圧力ＰＭとの関係を示した図である。

【図１２】圧縮上死点時筒内圧力標準状態ＰＣＹＬｂと開閉タイミング（位相）ＶＴと吸気管内の圧力ＰＭとの関係を示した図である。

【図１３】圧縮上死点時筒内圧力標準状態ＰＣＹＬｂと開閉タイミング（位相）ＶＴと吸気管内の圧力ＰＭとの関係を示した図である。

【図１４】圧縮上死点時筒内圧力標準状態ＰＣＹＬｂと機関回転数ＮＥとの関係を示した図である。

【図１５】点火時期ＳＡと圧縮上死点時筒内圧力ＰＣＹＬと１回転当たり気筒内に吸入される吸入空気量ＧＮとの関係を示した図である。

【図１６】点火時期ＳＡと機関回転数ＮＥとの関係を示した図である。

【図１７】第二の実施形態における燃料噴射量算出方法を示したフローチャートである。

【図１８】吸気下死点時筒内圧力標準状態ＰＣＹＬＩＮｂとバルブリフト量ＬＴと吸気管内の圧力ＰＭとの関係を示した図である。

【図１９】吸気下死点時筒内圧力標準状態ＰＣＹＬＩＮｂと作用角ＶＡと吸気管内の圧力ＰＭとの関係を示した図である。

【図２０】吸気下死点時筒内圧力標準状態ＰＣＹＬＩＮｂと開閉タイミング（位相）ＶＴと吸気管内の圧力ＰＭとの関係を示した図である。

【図２１】吸気下死点時筒内圧力標準状態ＰＣＹＬＩＮｂと機関回転数ＮＥとの関係を示した図である。

【図２２】燃料噴射量ＱＩＮＪと吸気下死点時筒内圧力ＰＣＹＬＩＮと開閉タイミング（位相、バルブオーバラップ）ＶＴとの関係を示した図である。

【図２３】第三の実施形態における点火時期算出方法を示したフローチャートである。

【図２４】圧縮上死点時筒内ガス温度標準状態ＴＣＹＬｂとバルブリフト量ＬＴと開閉タイミング（位相）ＶＴとの関係を示した図である。

【図２５】圧縮上死点時筒内ガス温度標準状態ＴＣＹＬｂとバルブリフト量ＬＴと開閉タイミング（位相）ＶＴとの関係を示した図である。

【図２６】圧縮上死点時筒内ガス温度標準状態ＴＣＹＬｂとバルブリフト量ＬＴと作用角ＶＡとの関係を示した図である。

【図２７】圧縮上死点時筒内ガス温度標準状態ＴＣＹＬｂとバルブリフト量ＬＴと作用角ＶＡとの関係を示した図である。

【図２８】圧縮上死点時筒内ガス温度標準状態ＴＣＹＬｂと吸気管内の圧力ＰＭとの関係を示した図である。

【図２９】圧縮上死点時筒内ガス温度標準状態ＴＣＹＬｂと機関回転数ＮＥとの関係を示した図である。

【図３０】受熱補正値ＫＴＷＡＬＬと、シリンダ壁温Ｔｗａｌｌと圧縮上死点時筒内ガス温度標準状態ＴＣＹＬｂとの差分と、機関回転数ＮＥとの関係を示した図である。

【図３１】吸入空気温変化補正値ＫＴＩＮと機関冷却水温Ｔｗと吸入空気量Ｇａとの関係を示した図である。

【図３２】内部ＥＧＲガス温度変化補正値ＫＴＥＧＲと内部ＥＧＲガス割合との関係を示した図である。

【図３３】内部ＥＧＲガス温度変化補正値ＫＴＥＧＲと前回の点火時期と前回の１回転当たりの燃焼ガス量との関係を示した図である。

【図３４】内部ＥＧＲガス温度変化補正値ＫＴＥＧＲと前回の空燃比との関係を示した図である。

【図３５】点火時期ＳＡと圧縮上死点時筒内ガス温度ＴＣＹＬと１回転当たりの吸入空気量ＧＮとの関係を示した図である。

【図３６】第四の実施形態における点火時期算出方法を示したフローチャートである。

【図３７】内部ＥＧＲガス割合標準状態定常値ＫＥＧＲｂとバルブリフト量ＬＴと開閉タイミング（位相）ＶＴとの関係を示した図である。

【図３８】内部ＥＧＲガス割合標準状態定常値ＫＥＧＲｂと作用角ＶＡと開閉タイミング（位相）ＶＴとの関係を示した図である。

【図３９】内部ＥＧＲガス割合標準状態定常値ＫＥＧＲｂと吸気管内の圧力ＰＭとの関係を示した図である。

【図４０】内部ＥＧＲガス割合標準状態定常値ＫＥＧＲｂと機関回転数ＮＥとの関係を示した図である。

【図４１】大気圧補正係数ＫＰＡと大気圧との関係を示した図である。

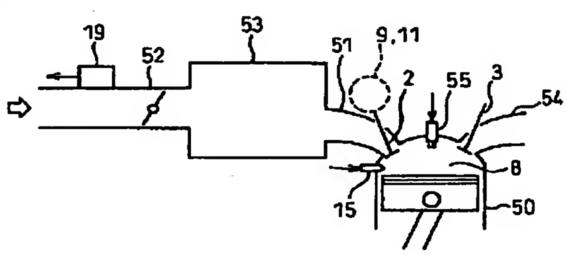
【図４２】背圧と機関回転数ＮＥと１回転当たりの吸入空気量ＧＮとの関係を示した図である。

【図４３】内部ＥＧＲガス割合を補正するための背圧補正係数と背圧との関係を示した図である。

【図４４】吹き返しガス量と吸気弁２の平均的な開口面積（バルブオーバラップ期間中における吸気弁の開口面積の平均値）と吸気弁２の平均的な前後差圧（バルブオーバラップ期間中における筒内圧と吸気管内の圧力との差分の平均値）との関係を示した図である。
【図４５】内部ＥＧＲガス割合定常値ＫＥＧＲＳＴと吹き返しガス量との関係を示した図である。
【図４６】前回の内部ＥＧＲガス割合の影響度（＝１－前回からの変化割合ＫＥＧＲＳＭ）と前回の内部ＥＧＲガス割合ＫＥＧＲＯと吸気管内の圧力ＰＭとの関係を示した図である。
【図４７】点火時期ＳＡと内部ＥＧＲガス割合ＫＥＧＲと１回転当たりの吸入空気量ＧＮとの関係を示した図である。
【図４８】点火時期ＳＡと機関回転数ＮＥとの関係を示した図である。
【図４９】第五の実施形態における点火時期算出方法を示したフローチャートである。
【図５０】筒内乱れＣＹＬＴＲＢとバルブリフト量ＬＴと開閉タイミング（位相）ＶＴとの関係を示した図である。
【図５１】筒内乱れＣＹＬＴＲＢと作用角ＶＡと開閉タイミング（位相）ＶＴとの関係を示した図である。
【図５２】筒内乱れＣＹＬＴＲＢと吸気管内の圧力ＰＭとの関係を示した図である。
【図５３】筒内乱れＣＹＬＴＲＢと機関回転数ＮＥとの関係を示した図である。
【図５４】点火時期ＳＡと筒内乱れＣＹＬＴＲＢと１回転当たりの吸入空気量ＧＮとの関係を示した図である。
【図５５】点火時期ＳＡと機関回転数ＮＥとの関係を示した図である。
【図５６】第六の実施形態におけるカム制御方法を示したフローチャートである。
【図５７】アクセル開度と機関回転数と選択すべきカムとの関係を示した図である。
【図５８】カム切換え遅れと機関回転数と冷却水温との関係を示した図である。
【図５９】カム切換え遅れと油圧との関係を示した図である。
【図６０】カムを切換えるための指示が出される時期と実際にカムが切換わる時期との関係等を示した図である。
【図６１】第六の実施形態における燃料噴射量算出方法を示したフローチャートである。
【図６２】応答補正係数とカムの種類と機関回転数と１回転当たりの吸入空気量ＧＮとの関係を示した図である。
【図６３】燃料噴射量と１回転当たりの吸入空気量との関係を示した図である。
【図６４】第六の実施形態における点火時期算出ルーチンを示したフローチャートである。
【図６５】点火時期とカムの種類と機関回転数と１回転当たりの吸入空気量ＧＮとの関係を示した図である。
【符号の説明】
１…内燃機関
２…吸気弁
３…排気弁
４，５…カム
６，７…カムシャフト
８…気筒内の燃焼室
９…バルブリフト量変更装置
１１…開閉タイミングシフト装置
１８…吸気管圧センサ
１９…エアフローメータ

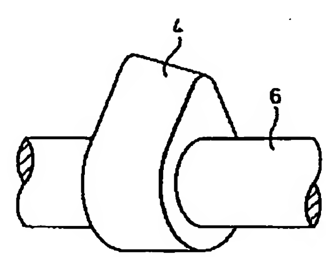
【図２】

図 2



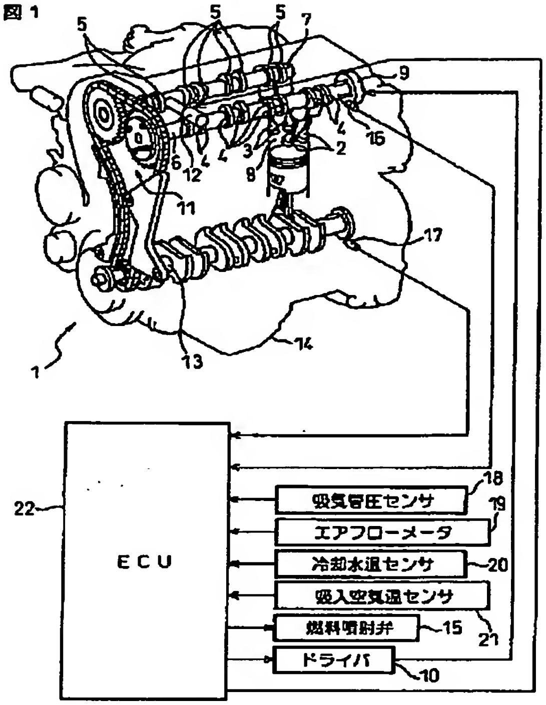
【図３】

図 3



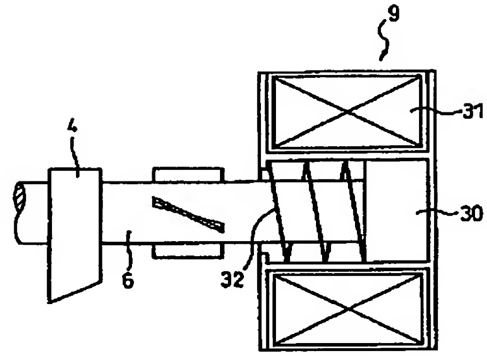
【図１】

図 1



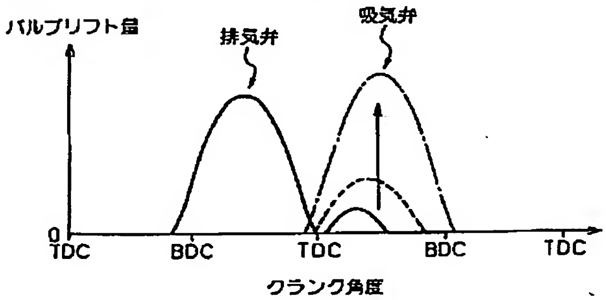
【図４】

図 4



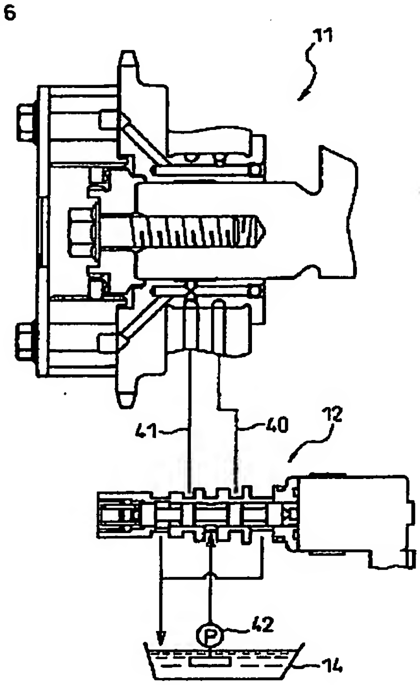
【図５】

図 5



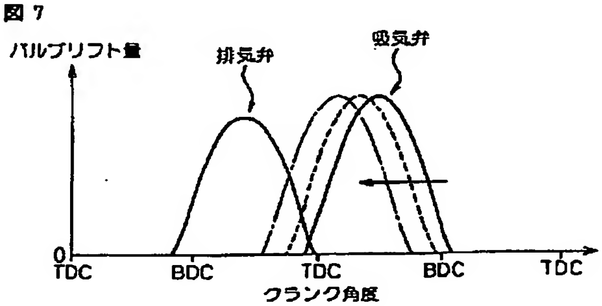
【図６】

図 6



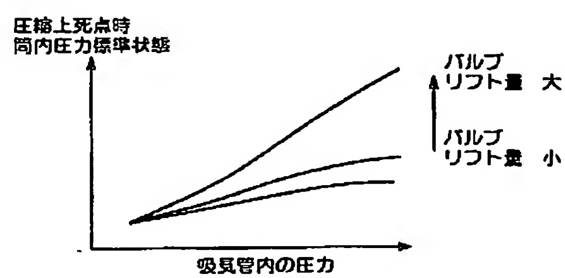
【図７】

図 7

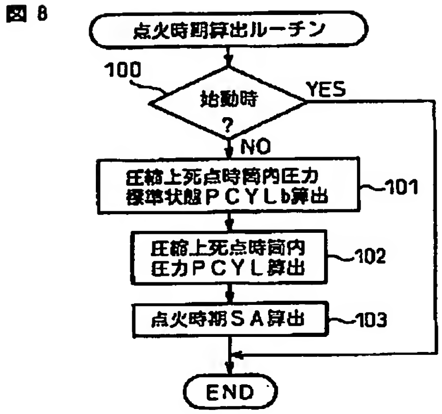


【図９】

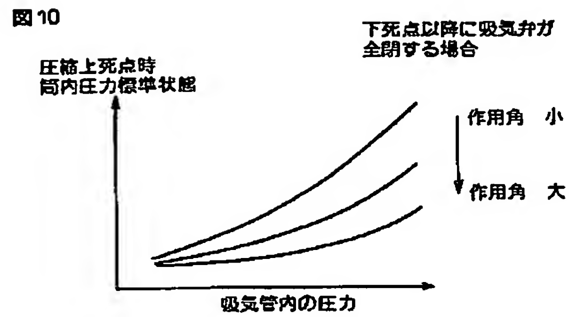
図 9



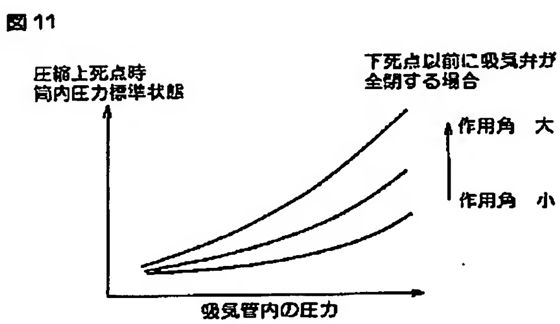
【図８】



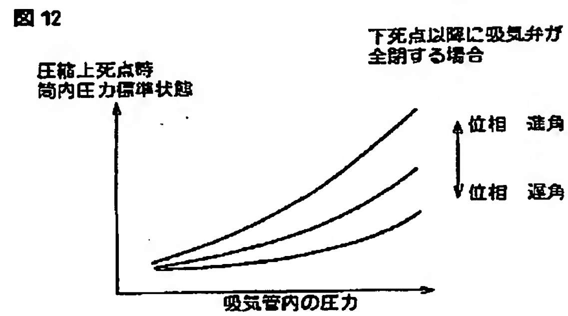
【図１０】



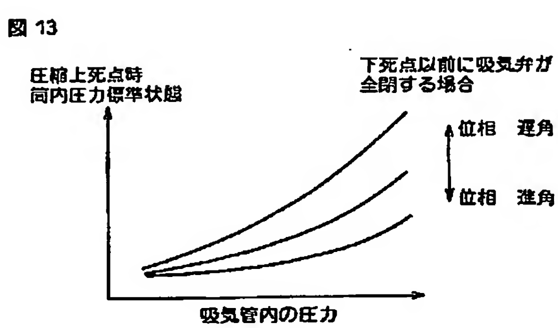
【図１１】



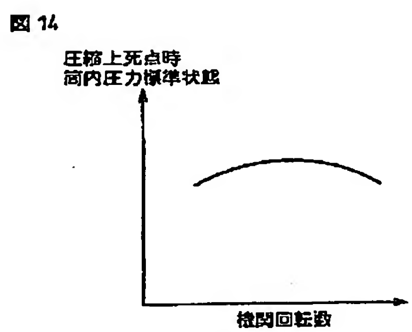
【図１２】



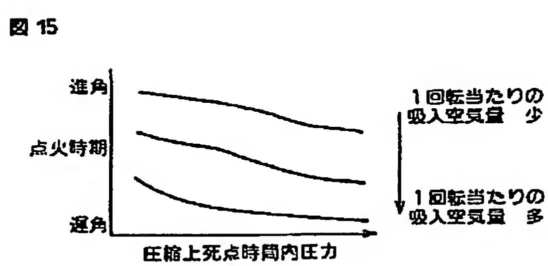
【図１３】



【図１４】

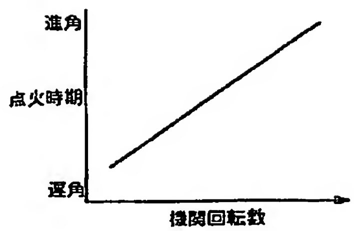


【図１５】



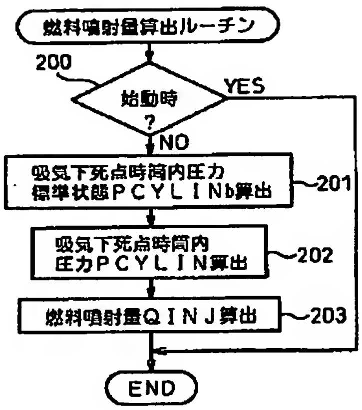
【図１６】

図 16



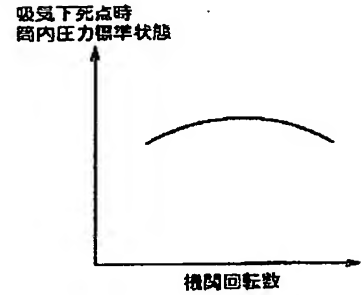
【図１７】

図 17



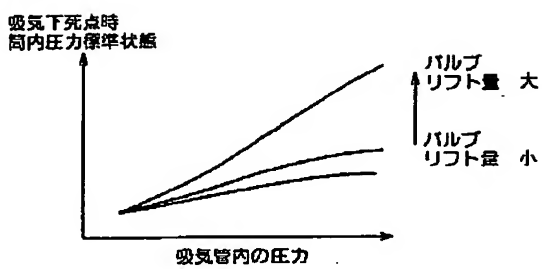
【図２１】

図 21



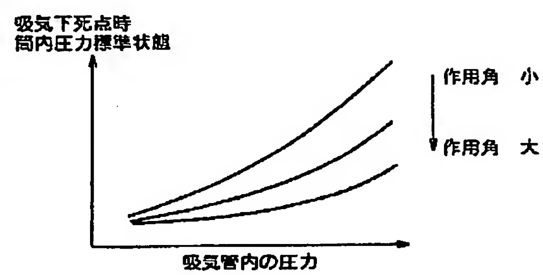
【図１８】

図 18



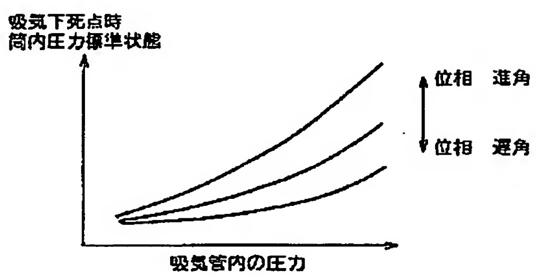
【図１９】

図 19



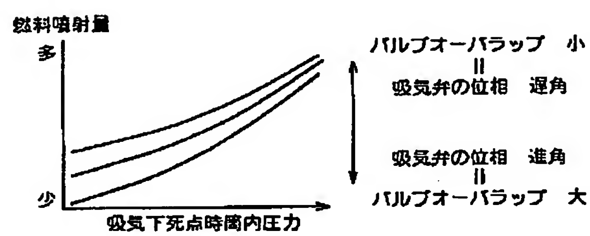
【図２０】

図 20



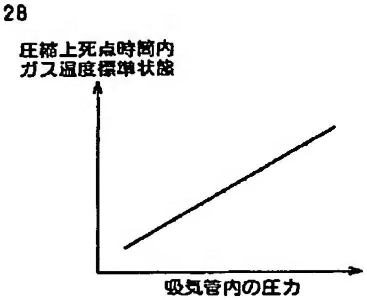
【図２２】

図 22



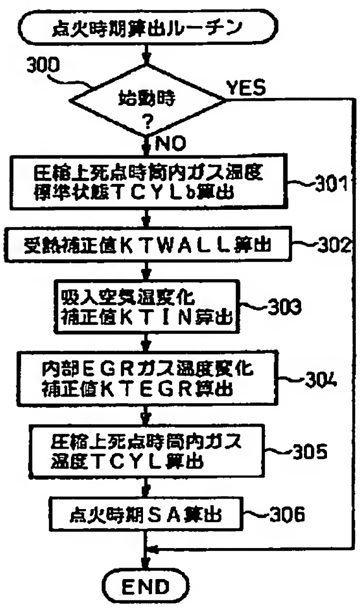
【図２８】

図 28



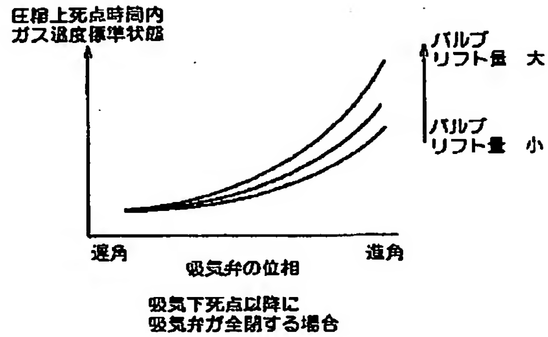
【図２３】

図 23



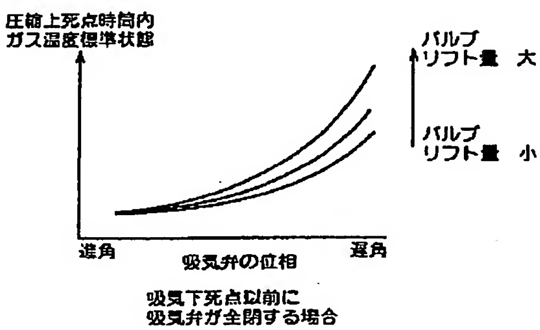
【図２４】

図 24



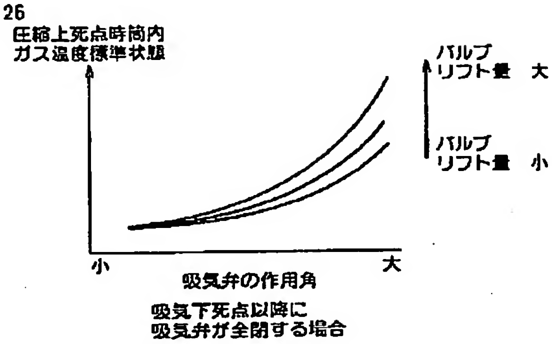
【図２５】

図 25



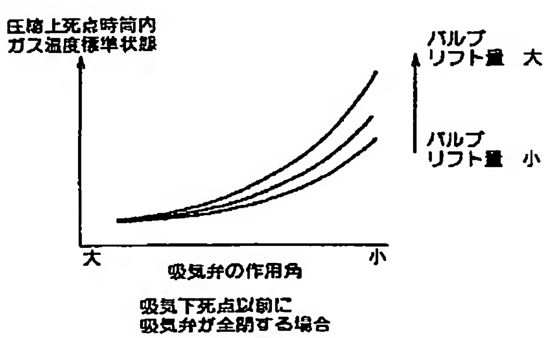
【図２６】

図 26



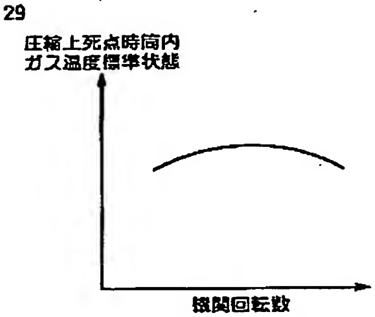
【図２７】

図 27



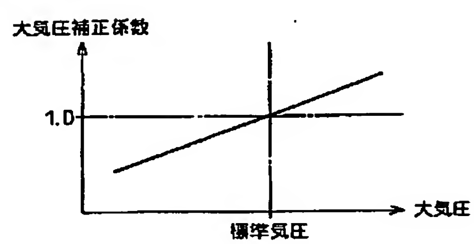
【図２９】

図 29

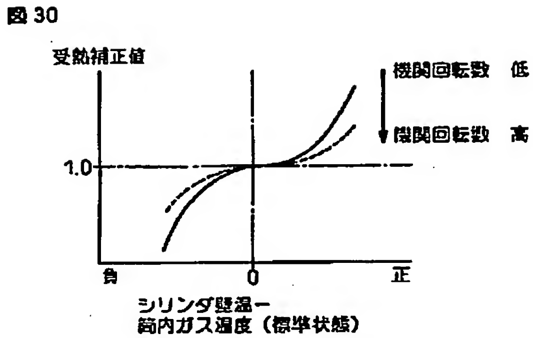


【図４１】

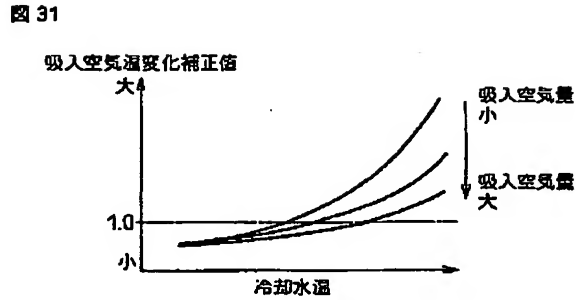
図 41



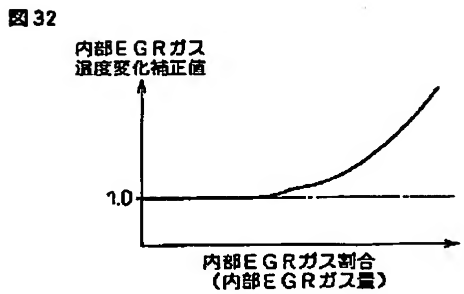
【図３０】



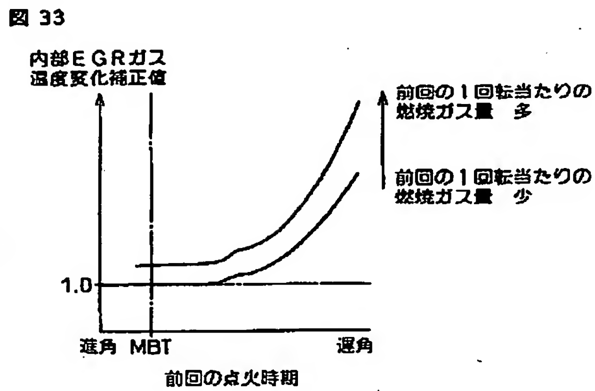
【図３１】



【図３２】



【図３３】



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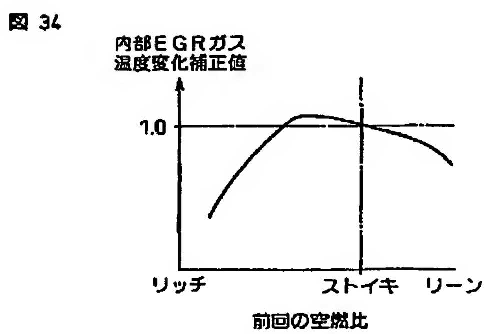

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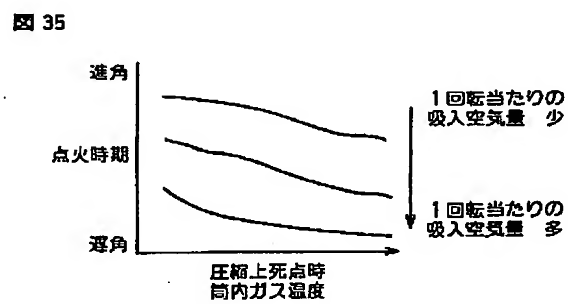

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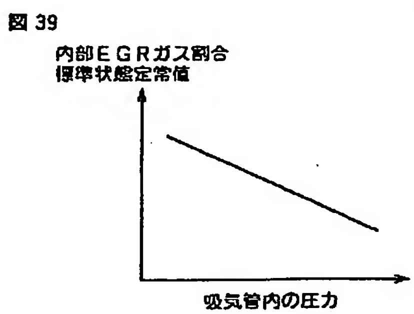

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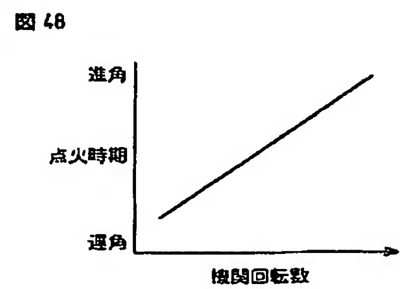

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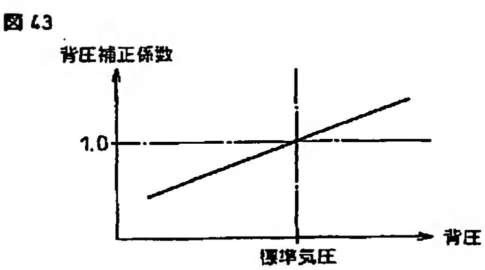

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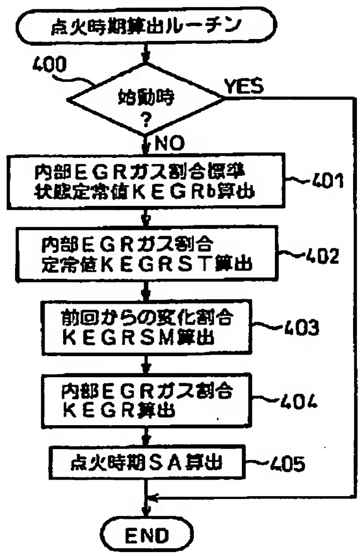

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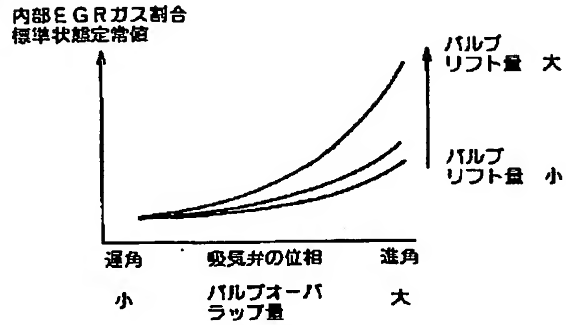

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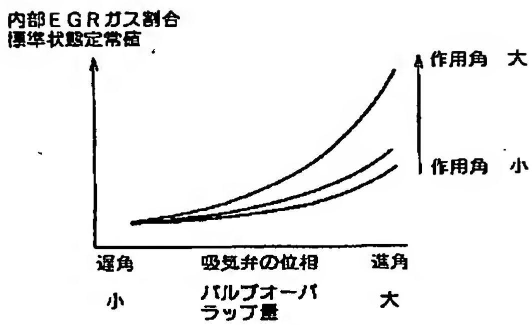

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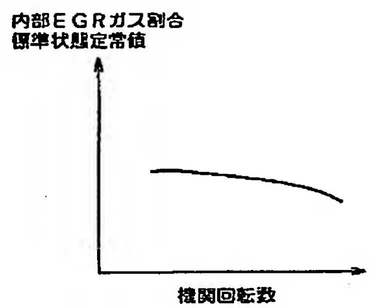

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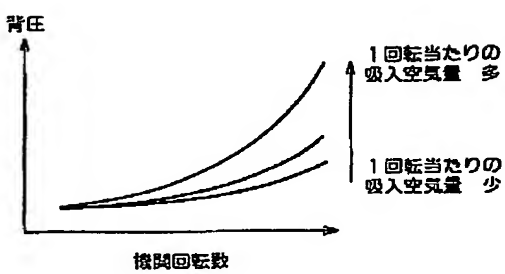

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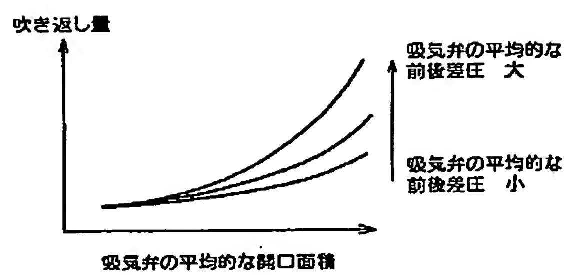

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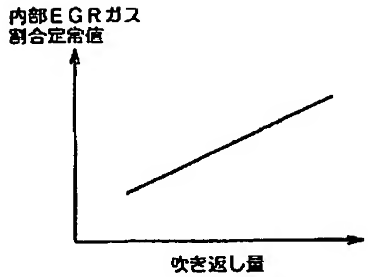

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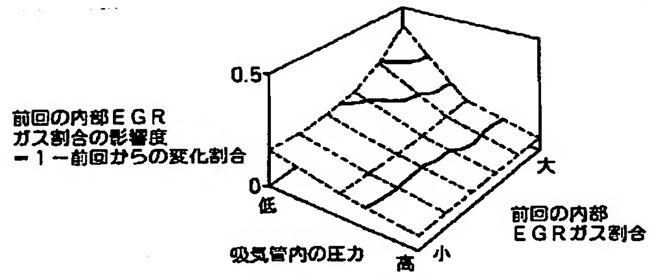

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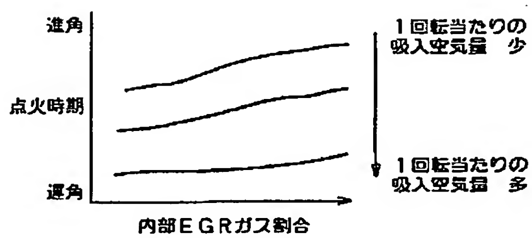

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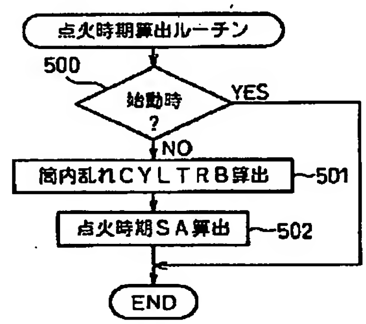

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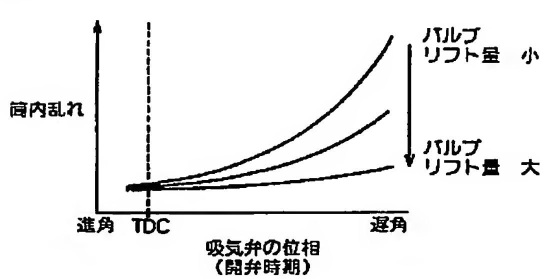

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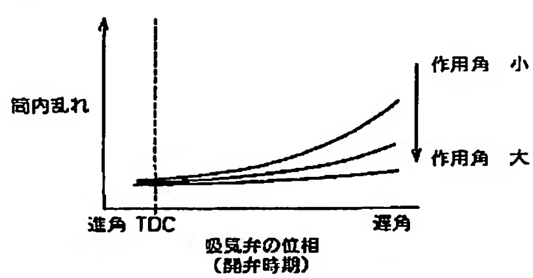

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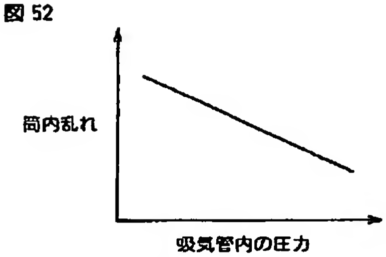

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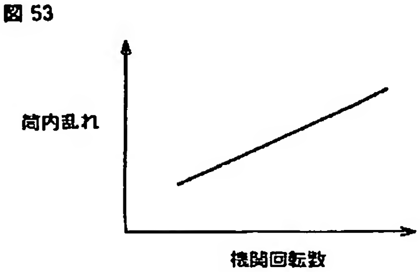

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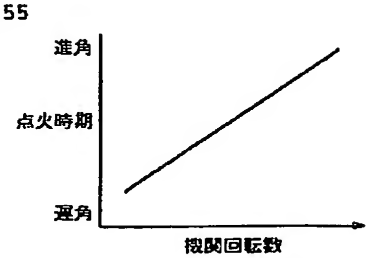

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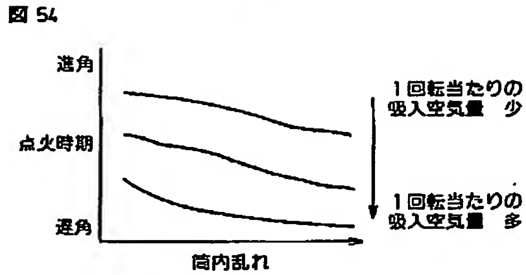

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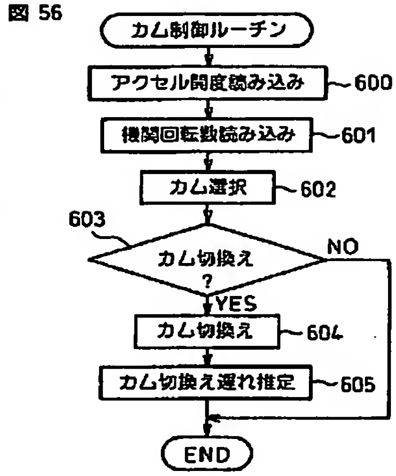

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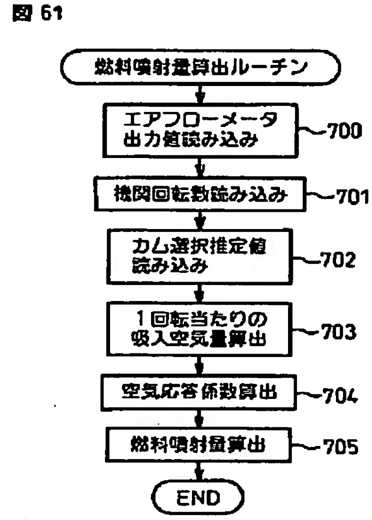

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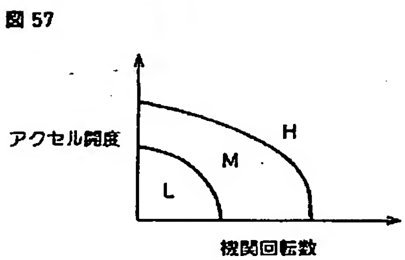

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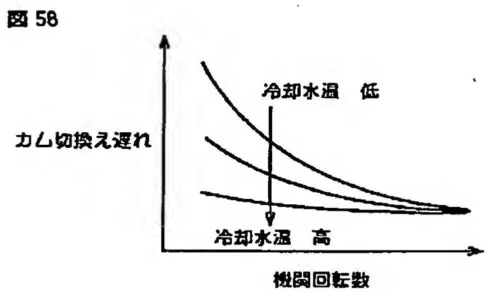

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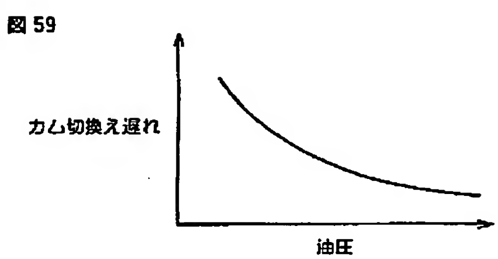

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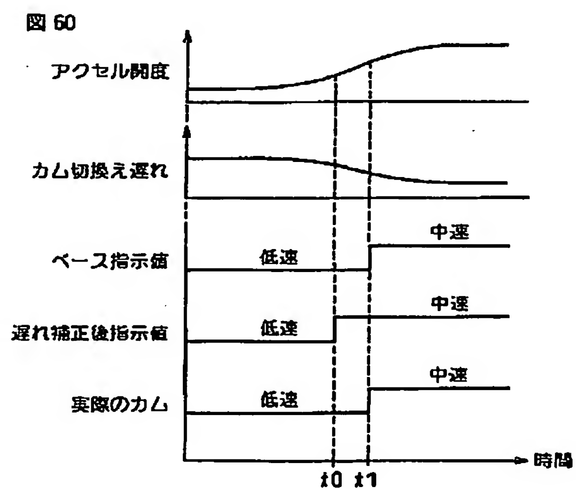

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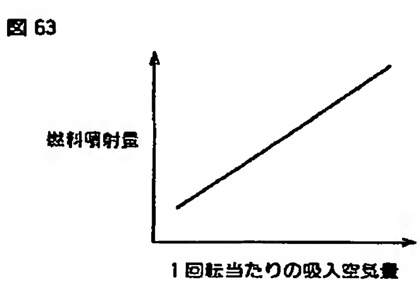

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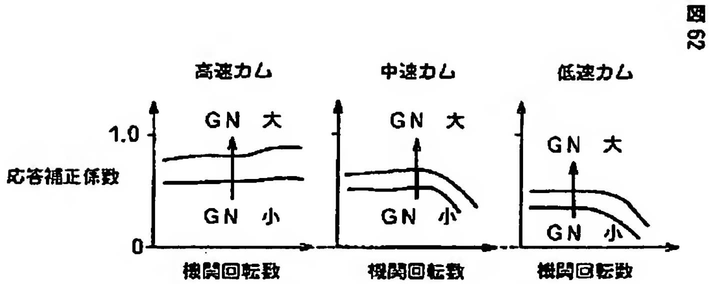

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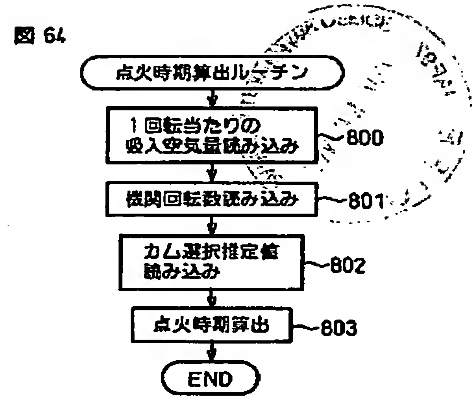

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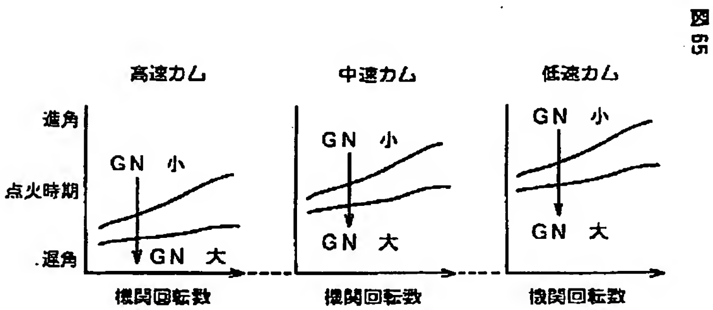

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3G092 AA06 AA11 BB01 DA01 DA02 DA04 DA09 DE03S DG02 DG05 DG09 EA17 EA21 EA22 EB03 FA06 HA01Z HA04Z HA05Z HA13X HA13Z HB01X HC01Z HC03Z HC09Z HD07Z HD08Z HE01Z HE08Z